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BART IN THE SAN FRANCISCO BAY AREA—

The Final Report of the BART Impact Program

SEPTEMBER 1979

NOTICE

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bstracts This is the final report of the BART Impact Program, a comprehensive study and aluation of the impacts of the San Francisco Bay Area Rapid Transit System (BART). The ogram analyzed the impacts of the BART system to assist in guiding future transportion planning and policy decisions in the Bay Area and in other urban areas.

The effects of BART on the Bay Area's transportation systems and travel behavior, the vironment, economics and finance, institutions and life styles, land use and urban delopment, and public policy were assessed.

The Program investigated what the impacts have been, why they have occurred, how nplementary actions might assure greater benefits from the BART system, and how the ssons learned from the BART experience might be useful to other areas and to state and deral officials. In addition, the distribution of the impacts among Bay Area residents s been described. The methods used to assess BART's impacts are documented for use in aluating the impacts of new transit systems and transportation improvements elsewhere.

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THE FINAL REPORT
OF THE BART IMPACT PROGRAM

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Prepared by the
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For The
U.S. DEPARTMENT OF TRANSPORTATION
And The
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Washington, D.C.

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The recently completed BART Impact Program was a comprehensive, policy-oriented study and evaluation of the impacts of the San Francisco Bay Area's new rapid transit system (BART).

The program was conducted by the Metropolitan Transportation Commission, a nine-county regional agency established by state law in 1970.

The program was financed by the U.S. Department of Transportation, the U.S. Department of Housing and Urban Development, and the California Department of Transportation. Management of the federally-funded portion of the program was vested in the U.S. Department of Transportation.

The BART Impact Program covered the entire range of potential rapid transit impacts, including impacts on traffic flow, travel behavior, land use and urban development, the environment, the regional economy, social institutions and life styles, and public policy. The incidence of these impacts on population groups, local areas, and economic sectors was measured and analyzed. The program was concluded with the interpretation of its findings and their implications for the planning of transportation and urban development in the Bay Area and other metropolitan areas.

SPONSOR'S NOTE

The BART Impact Program was a comprehensive, policy-oriented study and evaluation of the impacts of the San Francisco Bay Area's new rapid transit system (BART). The program began in 1972, and was completed in 1978. Financing for the Program was provided by the U.S. Department of Transportation, the U.S. Department of Housing and Urban Development, and the California Department of Transportation. Management of the Federally-funded portion of the Program was vested in the U.S. Department of Transportation (DOT). The Metropolitan Transportation Commission (MTC), a nine-county regional agency established by California law in 1970, administered the Program as prime contractor to DOT; the research was performed by competitively selected subcontractors to MTC.

The BART Impact Program studied the broadest feasible range of potential rapid transit impacts, including impacts on traffic flow, travel behavior, land use and urban development, the environment, the regional economy, social institutions and life styles, and public policy. The incidence of these impacts on population groups, local areas, and economic sectors was measured and analyzed.

The results of the BART Impact Program have been synthesized in BART in the Bay Area, the BART Impact Program Final Report (PFR). That report was prepared by MTC and presents MTC's conclusions from and interpretation of the Program's findings. In addition to the PFR, final reports for each of the individual projects in the Program were prepared by the consultants who conducted the research. The reports are listed at the end of this Note. The final reports are supported by numerous technical memoranda and working papers. The conclusions in those documents reflect the viewpoints of the respective consultants based on their research.

Readers of BART Impact Program reports should be aware of the circumstances and the setting in which BART was planned and built and the conditions under which the Program was conducted. An understanding of these factors is critical for interpreting the Program's findings and attempting to apply them to other areas.

First, it is important to note that the San Francisco Bay Area has a sound economy, a good system of highways and public transportation, and distinctive land use and development patterns shaped by the Bay and the hills around it. BART was approved and built during a period of vigorous growth in the Bay Area. The economy was expanding, suburban development was burgeoning, and major increments of highway capacity were being added. Also, the Bay Area already had extensive public transportation services. There were public carriers operating dense networks of local transit services on both sides of the Bay, and there was frequent transbay bus service from many parts of the East Bay to San Francisco. In 1972 before BART opened, approximately 10% of the total daily trips in the three BART counties were made on transit. All of these factors made it difficult in the study to isolate BART's effects from other influences that were affecting such things as travel behavior and urban development.

A second important point is that BART was planned and designed primarily to facilitate travel from outlying suburbs to downtown areas. Multiple stops are provided in the major central business districts, but in other respects BART is

more like a commuter rail system (with long lines and widely-spaced stations) than a New York or Chicago-style subway system of interlocking crosstown lines and frequent stops. The BART system was intended to rival the automobile in comfort, speed, and convenience. Contemporary issues like energy conservation, air quality and service for the transportation disadvantaged were not widely recognized and publicized concerns during the period of BART's design.

The institutional setting in the Bay Area was a third important influence on BART's development. BART was developed as a separate institution without full coordination among existing transportation and regional development planning agencies. BART's planners had to make assumptions about policies and development, many of which turned out to be contrary to policies ultimately adopted by municipalities in the BART District.

A critical element in the study design of the BART Impact Program was the definition of the No-BART Alternative (NBA), the regional transportation facilities and travel patterns judged most likely to have evolved by 1976 if BART had not been built. The definition of an NBA was essential since the Program defined an impact as the difference between what actually occurred with BART and what would have resulted without BART. One cannot be certain about what the region would have been like had BART not been built. But based on an analysis of the political and economic decision history of the Bay Area and the professional judgment of those involved in the Program, it was determined that no significant changes to the area's freeway and bridge systems as they actually were in 1976 would have occurred without BART. It was concluded further that the public transit network and services would have been very similar to what they were just before the start of BART transbay service. One consequence of this assumption is that the NBA provides lower levels of service and less capacity than the with-BART system, and attracts fewer riders. The NBA does not extrapolate beyond 1976 and does not consider how much additional capacity in the transportation system might eventually have been required because of increasing travel demand and congestion.

An important factor affecting the findings was that BART was not operating at its full service level during the period of study by the BART Impact Program. The frequency of trains, their operating speeds, the reliability of their operations, and the capacities provided in peak periods of travel by BART were considerably lower than those originally planned. Trains were running on 12-minute headways instead of the 4.5 minutes originally planned for each of the four lines (90 seconds where three lines converged). BART did not initiate service on all lines simultaneously in 1972 but instead phased in service. The most critical link, the Transbay Tube, was not opened until late 1974. Night service did not start until the end of 1975, and Saturday service started in 1977. Direct Richmond to Daly City service still is not operating, and it now appears that "full service levels," when they are attained, will not achieve the headways and average speeds announced in the original plans.

The final point is that BART had only been operating for a relatively short period of time when its impacts were studied. The impact assessment largely depends on data collected in the first four years of BART's operations. It is likely that some of its impacts, particularly those relating to urban development, will require more time to mature.

Final Reports

These documents are available to the public through the National Technical Information Service, Springfield, VA 22151:

Metropolitan Transportation Commission, "BART in the Bay Area. The Final Report of the BART Impact Program," MTC, 1979.

Gruen Associates, Inc. and DeLeuw, Cather & Company, "Environmental Impacts of BART," MTC, 1979.

Peat, Marwick, Mitchell & Co., "BART's First Five Years: Transportation and Travel Impacts," MTC, 1979.

Jefferson Associates, Inc., "Impacts of BART on Bay Area Institutions and Life Styles," MTC, 1979.

McDonald & Grefe, Inc., "The Economic and Financial Impacts of BART," MTC, 1979.

John Blayney Associates/David M. Dornbusch & Co., Inc., "Land Use and Urban Development Impacts of BART," MTC, 1979.

Booz, Allen & Hamilton Inc., "The Impact of BART on Public Policy," MTC, 1979.

Urban Dynamics Associates, "Implications of BART's Impacts for the Transportation Disadvantaged," MTC, 1978.

Alan M. Voorhees & Associates, Inc., "Federal Policy Implications of BART," DOT, 1979.

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Many people, too numerous to mention here, participated in the BART Impact Program during its seven years and made valuable contributions to it, as MTC staff members, as consultants, and as conscientious reviewers of all aspects of the Program. Among the many, two people must be singled out for special mention. Noel Marsh was the first Director of the Program for MTC and presided over it until its major study elements were under way. During the same period, Henry Bain was the Technical Advisor to the Program, and its technical organization and methodology were strongly influenced by his ideas. Although they bear no responsibility for this final report and its conclusions, they nevertheless were among those who played the most prominent roles in the organization and design of the Impact Program.

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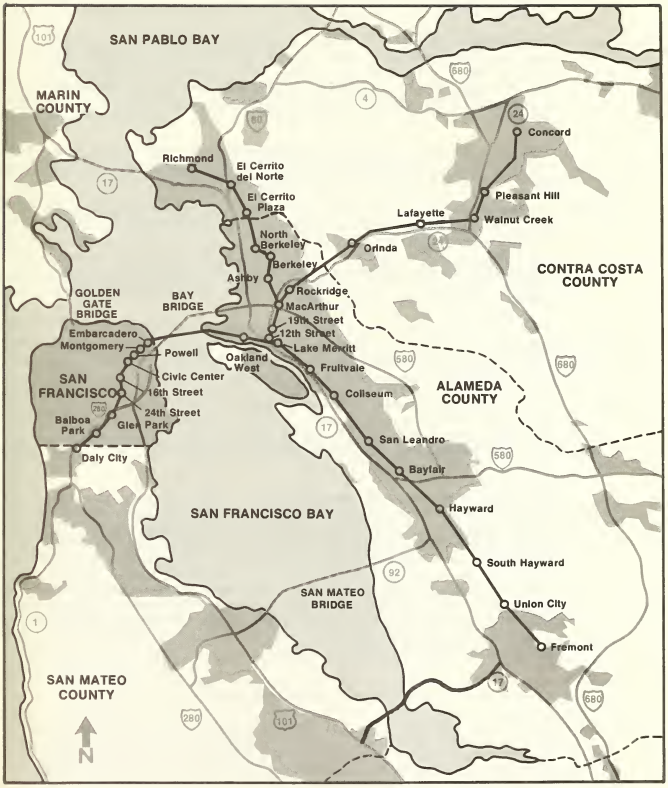
Gruen Associates and DeLeuw Cather, Inc.)


SAN PABLO BAY
MARIN COUNTY
Richmond
El Cerrito del Norte
El Cerrito Plaza
North Berkeley
Berkeley
Ashby
Rockridge
MacArthur
19th Street
12th Street
Lake Merritt
Fruitvale
Coliseum
Oakland West
GOLDEN GATE BRIDGE
BAY BRIDGE
Embarcadero
Montgomery
Powell
Civic Center
16th Street
24th Street
Glen Park
Balboa Park
Daly City
SAN FRANCISCO
SAN FRANCISCO BAY
SAN MATEO BRIDGE
SAN MATEO COUNTY
San Leandro
Bayfair
Hayward
South Hayward
Union City
Fremont
Concord
Pleasant Hill
Walnut Creek
Lafayette
Orinda
CONTRA COSTA COUNTY
ALAMEDA COUNTY
N
urbanized area
federal highway
interstate highway
state highway
BART
BART station
0 1 2 3 4 5m
0 1 2 3 4 5 6 7 8 km

BART: The Bay Area Rapid Transit System

Length: The 71-mile system includes 20 miles of subway, 24 miles on elevated structures and 27 miles at ground level. The subway sections are in San Francisco, Berkeley, downtown Oakland, the Berkeley Hills Tunnel and the Transbay Tube.

Stations: The 34 stations include 13 elevated, 14 subway and 7 at ground level. They are spaced at an average distance of 2.1 miles: stations in the downtowns are less than one-half mile apart, while those in suburban areas are two to four miles apart. Parking lots at 23 stations have a total of 20,200 spaces. There is a fee (25 cents) at only one of the parking lots. BART and local agencies provide bus service to all stations.

Trains: Trains are from 3 to 10 cars long. Each car is 70 feet long and has 72 seats. Top speed in normal operations is 70 mph with an average speed of 38 mph including station stops. All trains stop at all stations on the route.

Automation: Trains are automatically controlled by the central computer at BART headquarters. A train operator on board each train can override automatic controls in an emergency.

Magnetically encoded tickets with values up to $20 are issued by vending machines. Automated fare gates at each station compute the appropriate fare and deduct it from the ticket value.

Fares: Fares range from 25 cents to $1.45, depending upon trip length. Discount fares are available to the physically handicapped, children 12 and under, and persons 65 and over.

Service: BART serves the counties of Alameda, Contra Costa and San Francisco, which have a combined population of 2.4 million. The system was opened in five stages, from September 1972 to September 1974. The last section to open was the Transbay Tube linking Oakland and the East Bay with San Francisco and the West Bay.

Routes are identified by the terminal stations: Daly City in the West Bay, Richmond, Concord and Fremont in the East Bay. Trains operate from 6:00 a.m. to midnight on weekdays, every 12 minutes during the daytime on three routes: Concord-Daly City, Fremont-Daly City, Richmond-Fremont. This results in 6-minute train frequencies in San Francisco, downtown Oakland and the Fremont line where routes converge. In the evening, trains are dispatched every 20 minutes on only the Richmond-Fremont and Concord-Daly City routes. Service is provided on Saturdays from 9 a.m. to midnight at 15-minute intervals. Future service will include a Richmond-Daly City route and Sunday service.* Trains will operate every six minutes on all routes during the peak periods of travel.

Patronage: Approximately 146,000 one-way trips are made each day. Approximately 200,000 daily one-way trips are anticipated under full service conditions.

Cost: BART construction and equipment cost $1.6 billion, financed primarily from local funds: $942 million from bonds being repaid by the property and sales taxes in three counties, $176 million from toll revenues of transbay bridges, $315 million from federal grants and $186 million from interest earnings and other sources.

March 1978

*Sunday service began in July, 1978

PREFACE

This is the final report of the BART Impact Program, a comprehensive study and evaluation of the impacts of the San Francisco Bay Area Rapid Transit System (BART). The Program's fundamental objective was to analyze the impacts of the BART system to assist in guiding future transportation planning and policy decisions in the Bay Area and in other urban areas.

The Impact Program was initiated in 1972. Gathering of pre-BART baseline data began at that time, and research in the first of the major impact study areas began in 1974.

The Program has focused on decisions, actions, and their results. It has investigated what the impacts have been, why they have occurred, how complementary actions might assure greater benefits from the BART System, and how the lessons learned from the BART experience might be useful to other areas and to state and federal officials. In addition, the distribution of the impacts among Bay Area residents has been described. The methods used to assess BART's impacts have been documented for use in evaluating the impacts of new transit systems and transportation improvements elsewhere.

The Impact Program was funded by the U.S. Department of Transportation (DOT) and the U.S. Department of Housing and Urban Development (HUD). The Metropolitan Transportation Commission (MTC) of the San Francisco Bay Area administered the program as prime contractor to DOT. Most of the research effort was accomplished by competitively selected subcontractors.

The Program was organized into six major projects and several smaller efforts:

- The Environment Project studied BART's direct and indirect effects on air quality, noise levels, visual harmony and other physical and social factors that influence the quality of life. The major subcontractors were Gruen Associates and DeLeuw Cather & Co.

- The Transportation System and Travel Behavior Project considered the characteristics and performance of the Bay Area's transportation system. It measured BART's influence on levels of service, the cost of travel, travel patterns, highway congestion, and on the travel behavior of various population groups. The major subcontractor was Peat, Marwick, Mitchell & Co.

- The Land Use and Urban Development Project assessed the nature and extent of BART's influence on land use and development in the San Francisco Bay Area. It studied the location decisions of employers, workers and households; the development decisions of housing and commercial developers; retail trade and shopping patterns; and property values and rents. The major subcontractors were John Blayney Associates and David Dornbusch & Co.

- The Economics and Finance Project studied the changes in regional sales, income and employment which were stimulated by BART's capital

and operating expenditures. The tax incidence and tax burden of financing both classes of expenditures were determined. The study also included analyses of the effects of BART's financing on public finance policies in the region and of BART's influence on the Bay Area's attractiveness to business and commerce. The major subcontractor was McDonald and Grefe, Inc.

- The Institutions and Life Styles Project examined BART's effects on the life styles of families of the system's patrons and on the functioning of key social institutions in the area. The major subcontractor was Jefferson Associates.

- The Public Policy Project analyzed the influence of BART on local public policy actions and the public policy processes of local, regional, and state governments. The major subcontractor was Booz, Allen, Hamilton & Co.

- The Decision History Project analyzed and described the principal decisions and events which produced the BART system. It chronicled the process by which specifications for BART's financing, design, construction, and operations were developed. The major subcontractor was McDonald, Smart Inc.

- The Implications for the Transit Disadvantaged Project described BART's impacts on the lives of minority individuals. It focused on the mobility, environmental and financial impacts of BART on this special population group. The subcontractor was Urban Dynamics Associates.

TRAIN INTERIOR.

STATION PLATFORM.

VIEWS OF BAY AREA RAPID TRANSIT SYSTEM Photos supplied by BART

BART IN THE BAY AREA

THE FINAL REPORT OF THE BART IMPACT PROGRAM

OVERVIEW

BART was planned in the 1950's and 1960's in an atmosphere of high hopes and expectations. It was to be automated, fast, comfortable, and attractive; a modern, space-age version of the rail transit systems in the leading cities of the world, and an appropriate symbol of the pride with which San Francisco Bay Area residents regard their metropolitan region. BART was expected to increase capacities in the major travel corridors; to encourage a city-centered type of growth; to preserve and enhance the vitality of the major cities and urban sub-centers by forestalling an increase in traffic congestion; and to attract an increasing share of the nation's economic growth to the region. BART's planners forecast that a majority of its patrons would be former motorists whose use of the system would decrease traffic congestion and reduce the need for further highway construction. Some of these hopes were well-founded; some were unrealistic; and some may be realized as the system matures, if they are supported by a favorable economic climate, by appropriate governmental policies, and by continued improvements in BART service.

The goals for BART which have been attained in the first few years of its operations are the results of basic design and operating decisions:

- The system has provided a substantial increase in the capacities of the major regional travel corridors in the central Bay Area. The increase in services planned for BART within the next few years will permit a larger growth in travel to the cities of San Francisco and Oakland than would have been possible without increases in other transportation facilities and services. This is a particularly important benefit in the central Bay Area where regional vehicular traffic is confined to fairly narrow corridors on bridges, through tunnels, or in urbanized areas along the Bay shore.

- BART has helped to maintain the vitality of the central cities by enabling the corridors in which it operates to accommodate increased travel volumes without increased traffic congestion. The system has absorbed most of the increase in peak period travel in these corridors since its service began.

- BART has been integrated into the Bay Area with a minimum of environmental and social disruption. This is due to careful design and to decisions to place major portions of the system underground or adjacent to other transportation facilities.

- A substantial proportion of BART riders are former motorists. There are a number of reasons for this. The system is attractive and comfortable. It provides direct service to several major business and commercial centers where parking is difficult and expensive. It has decreased transit travel times for many trips between suburban areas

and the central cities, and it provides an alternative to driving in congested traffic. While BART service is not competitive with automobile travel times for most trips, it is competitive with automobiles in terms of out-of-pocket travel costs.

BART is a relatively specialized transportation resource in the Bay Area. Its most important travel advantages are for long suburban-to-central-city trips, particularly commute trips made in peak periods of travel. About two-thirds of all trips on the system on weekdays are trips to or from work, and about half are trips made during peak periods of travel.

The system's primary impacts to date have taken place at the local, rather than the regional level. For example, the economic growth of the area as a whole has not been affected by BART. The Bay Area is highly regarded as a place to live and work, and BART was built to serve the growth which was occurring in the 1950's and 1960's, and which was expected to continue. However, the system has encouraged a city-centered concentration of activities and it has provided access to a larger work force within its service area, two circumstances which can help make an area attractive to business. If BART's service continues to improve, and if traffic congestion or fuel shortages impede travel by automobile in the future, the system's attractiveness as a transportation mode will increase. It may then become a measurable influence on the level of economic activities in the region.

BART has affected the spatial distribution of activities in the central Bay Area in a number of ways. In some cases it has influenced urban development patterns directly through its service and physical effects. In other instances BART has been a catalyst for public policies and projects which have worked with the system's direct effects to influence land uses. Many other factors which cannot always be separated from the influence of BART have been important in shaping Bay Area urban development patterns. They include the price and availability of land, the extensive system of freeways and highways, alternative public transportation services, and the level of market demand for new developments. In other words, BART has been one component of forces influencing individual location and investment decisions which, in turn, give rise to urban development patterns.

BART's most notable land use impacts to date have occurred in downtown San Francisco and Oakland, where the system has been both a direct and indirect cause of a shift in new office construction to its station areas. For example, in downtown San Francisco most of the 22.5 million square feet of office space built since 1965 is within 1,500 feet of the four downtown BART stations. Two events for which BART was a catalyst, a $35 million Market Street Development Project and new zoning codes adopted by the city have contributed to the redirection of growth.

In downtown Oakland, where the total amount of new office space has been much smaller than that which was added in San Francisco, about three-fourths of the new construction was within 1,500 feet of the two downtown stations. BART influenced the location decisions for about 80% of this new space, primarily because it enabled the City Center

Redevelopment Project, which is adjacent to a BART station, to be expanded. The funds spent for the BART station were used as part of the local credits to obtain matching Federal funds for the Project's expansion.

The Program's findings demonstrate that BART has affected land uses only when supportive conditions--such as zoning provisions, community support, and market demand--are present. In the absence of a supportive environment for land use changes the system has had little influence. For example, several residential or mixed residential and commercial areas around BART stations were downzoned in response to residents' wishes to preserve the existing character of the neighborhoods. In these areas BART has not induced land use changes. Instead, its effect was that of coalescing anti-development sentiment in the communities.

BART has not reversed declining market trends or initiated developments in areas where demand for new developments is lacking. For example, a number of BART stations are in areas where housing is deteriorating and where there is little commercial activity. In some of these areas the BART stations are isolated from activity centers by freeway structures, railroads tracks, or land-intensive light industry. No land use changes have occurred in these areas in response to BART. These findings highlight the importance of locating transit stations in areas conducive to development if land use impacts are to be realized.

BART's impacts on Bay Area land uses may become more widespread in the future. There are several reasons to expect these results:

- Large-scale land use changes tend to occur slowly, and BART service is relatively new. Many land use impacts may not yet have had time to develop.

- BART has influenced the decisions of some Bay Area residents about where to live, work, and shop. These changes in behavior patterns can be expected to become more widespread as BART's ridership increases. They are then likely to influence decisions about the locations of homes, shops, and workplaces.

- Increases in traffic congestion or in the price of gasoline will increase BART's attractiveness as a transportation mode. This will also tend to increase the attractiveness of locations near the system's facilities.

BART's patronage has not reached forecast levels, largely because early patronage predictions were based on unrealistic expectations of the level of service to be provided. In 1962, when patronage was predicted to be 259,000 one-way trips per day at full service levels of operations, it was expected that trains would run every 90 seconds in downtown San Francisco, through the Transbay Tube, and elsewhere where routes merge. Today trains operate at about six minute intervals where routes merge, and direct service on one transbay route has not yet been introduced. Patronage in late 1978 was 146,000 one-way trips on weekdays, and a recent forecast predicts 180,000 trips by 1981. Although train intervals are expected to be reduced to four-and-one-half minutes when the

additional transbay route is introduced, technical limitations have made it unlikely that BART trains will ever run every 90 seconds.

Patronage levels have also been adversely affected by the system's unreliability. The effects of an unexpectedly high rate of equipment failures have been exacerbated by some design elements. For instance, trains from two East Bay lines merge in a complicated junction in downtown Oakland, where a malfunctioning train can delay service on both lines. A system-wide lack of sufficient facilities for removing malfunctioning trains from the main line causes frequent and widespread delays. Although considerable resources have been devoted to solving BART's equipment and design problems, the system has a reputation for unreliability which has affected the level of patronage.

This aspect of the BART experience points to the importance of designing rail transit in anticipation of inevitable equipment failures. It also suggests that funding provisions for new rail transit should be flexible. Such provisions would have helped to alleviate BART's problems when construction fund shortages developed as a result of unforeseen circumstances such as an inflationary cost spiral. Cut-backs were made in essential BART design features -- such as sidings -- when construction fund shortages developed. The resulting operational problems with their adverse effects on patronage which are described above continue to plague the system.

BART's capital cost is $1.6 billion. Eighty percent of the capital costs have been funded from local sources, largely from bond issues secured by local property and sales taxes. The majority of the taxes for debt service on the bonds are paid by households.

Expenditures for building and operating BART have not resulted in major, long-term economic benefits or burdens in the Bay Area. The economy is varied and the region's resources are generally well utilized. Therefore, while BART construction and operations have resulted in a large public debt and a large yearly expenditure of funds, they have not resulted in a marked stimulation or depression of employment, incomes, and sales. The effects of inflation have resulted in a smaller relative tax burden for debt service on BART's general obligation bonds than originally anticipated. However, the inflationary effects, together with BART's equipment problems, have reulted in an increasing level of operating expenditures. BART farebox revenues cover about 36% of operating costs, a ratio similar to that for bus operators in the Bay Area.

BART's operating costs, at the 1976 interim level of services, are greater than those of most other rail transit operators in terms of costs for each trip carried. However, they are approximately equal in terms of costs per passenger mile of travel. This is because the average length of a trip on BART (13 miles) is greater than the typical trip made on most other urban transit systems. BART's operating costs per passenger and per passenger-mile are expected to decrease in the future, in terms of constant dollars, as ridership increases.

The Program's findings imply that goals for a new rail transit system must be based on choices between alternative sets of costs and benefits. Difficult planning and policy decisions must be made in budgeting for the construction process and in allocating benefits and costs among the communities within a region, and between groups of citizens in the population. The Impact Program findings indicate the consequences of a number of alternatives, but appropriate choices must be made on the basis of individual communities' priorities and needs.

FACTORS WHICH HAVE AFFECTED THE PROGRAM'S FINDINGS

The findings and conclusions of the Impact Program should be tempered by the understanding that BART is a new system which is not yet providing the full extent or quality of services planned. They should be applied to other areas with some caution because the geography, institutions, and transportation services in the Bay Area differ in important respects from those of many other areas. Finally, the methods of study and evaluation used by the Program have conditioned the findings.

BART service is relatively new and incomplete. It began on one line in 1972 and was expanded in incremental steps. The Transbay Tube which connects the East Bay and West Bay was opened in September, 1974. One planned transbay route, between Richmond and Daly City, is not yet in service. As a result, travel on BART between Richmond and Daly City requires a transfer between lines.

Because BART has not achieved reliable, full-service levels of operations, the impacts which have been measured by the Program are not those of a mature, fully operating system. However, wherever possible current trends have been extrapolated to estimate the probable future effects of BART at higher levels of service.

BART is dissimilar in some respects to other urban rail systems in the United States. The system was designed to provide high quality transit service, particularly for long-distance commuters to downtown employment centers. It has widely-spaced stations in suburban areas and a single line through each city it serves. Consequently it serves, in part, as a commuter railroad, especially in suburban areas. However, the level of service provided during off-peak travel periods and the downtown distribution service--provided by multiple stations in the major central business districts--are more extensive than those generally provided by commuter railroads.

The institutional setting of Bay Area transit also differs from that in many other urban areas. Transit services are operated by separate agencies. When BART was planned no single authority was empowered to coordinate transit services. The Metropolitan Transportation Commission (MTC) which was established in 1971 is now actively engaged in implementing coordinated policies for the Bay Area.

The Program's methodology is an additional important influence on the findings. The evaluations are based on the differences between changes observed to have occurred in the Bay Area as of 1976 with BART, and those

which were judged likely to have occurred if the 1962 decision to build BART had not been made. A close historical study of economic and political decisions suggested that if BART had not been built, the Bay Area would have had in 1976 a public transit system much like the one that actually was operating there in 1973. The 1973 system, with some minor changes, was defined uniformly in the BART Impact Program as the transit component of a hypothetical No-BART Alternative (NBA) system. This system, which consisted chiefly of local and express buses, would have provided less service and less capacity than the with-BART system provided in 1976. It would also have attracted fewer patrons. The NBA assumed no highway facilities beyond those existing in 1976. It did not extrapolate beyond 1976 and did not consider any changes in the transportation system which might have been required as a result of increasing travel demand and congestion.

Some features of the NBA continue to be debated by transportation experts. One reason for the continued debate is the fact that it is difficult to separate the impacts of BART from those of other influences in the Bay Area. The area is highly developed, attractive, and is generally considered a desirable place to live and work. BART was approved and built during a period of growth. Moreover, the area has a well-developed highway and transit system which includes buses, a commuter railroad, and ferry boats in addition to BART. Further, many Bay Area residents have strong concerns for protecting the natural and urban environment and for encouraging urban vitality. These concerns have resulted in the curtailment of freeway expansion, and they were important in the promotion and development of BART. However, BART has also played a causal role in discouraging new freeway development. For example, anticipations of the system's travel capacities were important arguments in the opposition to a proposal for a new bridge across the Bay in the 1960's. In other words, many impacts of BART are so closely intertwined with those of other forces affecting the Bay Area that the definition of an appropriate NBA was a difficult and controversial task. It is clear that different assumptions would have produced different evaluations in some instances.

The Impact Program's methodology is described in greater detail in Chapter 1 and Appendix B. The Program's conclusions are summarized at the beginning of each of the chapters in the body of the report, and in the Summary and Conclusions Section.

CHAPTER 1

INTRODUCTION AND BACKGROUND

PURPOSE OF THE IMPACT PROGRAM

"We shall solve the city problem by leaving the city"... Henry Ford, 1912

"Our national welfare depends on the provision of good urban transportation with the proper use of private vehicles and modern mass transit to help shape, as well as serve, urban growth"...President John F. Kennedy, 1962

Expectations that transportation systems will influence the growth and shape of urban areas are well grounded in American historical experience. Nineteenth century cities were physically and socially restructured in conjunction with new public transportation systems. Steam trains and horse-drawn omnibuses, ferry boats, cable cars, and electric streetcars extended the effective range of city life and city influence, and at the same time helped create centralized and specialized downtown areas. In the twentieth century automobile-based mobility permitted a new urban organization which reinforced the premise that transportation is a primary element in shaping urban growth.

Current proposals to build new rail transit systems to solve problems ranging from traffic congestion to social, economic, and environmental deterioration demonstrate that transportation systems continue to be regarded as a means to influence urban development. However, the high cost of building new rail systems and the competition for scarce funds have resulted in concerns at all levels of government about whether the expectations are realistic.

The BART Impact Program is an attempt to respond to those concerns and to assess comprehensively the effects of adding a modern rail transit system to an urban area where a well-developed public transportation system is in place. The Program's purpose has been to analyze the impacts of BART, the Bay Area's new rail rapid transit system, to provide a better understanding of its effects on travel behavior, urban growth patterns, the economy, and on other aspects of urban life.

BART was the first new regional rail transit system to be built in the United States in over fifty years. It was specifically designed to rival automobiles in terms of comfort, convenience, and speed. Its computer controls for operations are the first use of this technology for a regional rail transit system. It provides a valuable opportunity to analyze the impacts of modern rail transit, particularly at this time when similar systems are being proposed or built for other urban areas.

The Program has special significance in view of the plight of many central cities in the United States, where jobs, population, and financial resources have been drained in the outward shift to suburban areas. The people who remain in these cities, many of whom are minorities, are deprived of many of the urban services, the employment, and the housing necessary for their well-being. The Program's analysis of

the impacts of BART addresses many of these concerns. In addition, special attention is given to the important issues of air quality, and energy use, and to the environmental and social effects of new transportation facilities.

This final report of the BART Impact Program describes and integrates the major results of the work of all research projects undertaken by the staff and contractors.

The Program's findings have been conditioned by the characteristics of BART, by BART's setting in the Bay Area, and by the methodology and assumptions of the research. These factors are discussed in the following sections to aid readers' interpretations of the findings.

A DESCRIPTION OF BART

THE SETTING IN THE BAY AREA

Transportation needs in the Bay Area are the products of two basic and inter-related characteristics, topography and settlement patterns. New residents have been attracted by the area's climate, economic opportunities, and its attractive natural and urban features. As a result, population has increased faster than that of the nation as a whole since the turn of the century. The pattern of settlement, illustrated in Figure 2, shows that urbanization has been largely confined to the natural corridors formed by the Bay and the hills. The City of San Francisco, the dominant commercial, financial, and cultural center, occupies the tip of the peninsula in the West Bay. The urbanized area extends south from San Francisco through San Mateo County and north across the Golden Gate to Marin County. The Oakland-Berkeley hills divide the urbanized East Bay into the settlements along the Bay and those to the east, beyond the hills, in central Contra Costa County.

A number of varied and some colorful transportation solutions have been developed in response to problems caused by the constraints of hills, narrow corridors, and the Bay. Streetcars, cable cars, buses, ferry boats, commuter railroads, and an extensive freeway and highway system serve transportation needs in the region. Bridges connect San Francisco with the northern and eastern Bay Area communities. BART, a new regional rail transit system, operates in the three central Bay Area counties of San Francisco, Alameda, and Contra Costa, which had a combined population of 2.4 million in 1970.

THE BART SYSTEM

The 71-mile BART system connects the City and County of San Francisco in the West Bay with Oakland, Berkeley, and suburban communities in the East Bay counties of Alameda and Contra Costa by means of the underwater Transbay Tube. BART has four lines which radiate from downtown Oakland. They are named for their termini; Richmond, Concord, Fremont, and Daly City. A single BART line serves the cities along the routes. Currently, two transbay routes are operated, one between Concord and Daly City, and one between Fremont and Daly City. One route operates within the East Bay, between Fremont and Richmond.

The BART routes are located in major traffic corridors to provide convenient service to major centers of population in the three BART District counties. Within the corridors the lines are generally located along pre-existing transportation rights-of-way such as city streets, highways, or railroads. (Bay Area highways and BART routes are shown in Figure 2.)

BAY AREA HIGHWAY SYSTEM AND BART

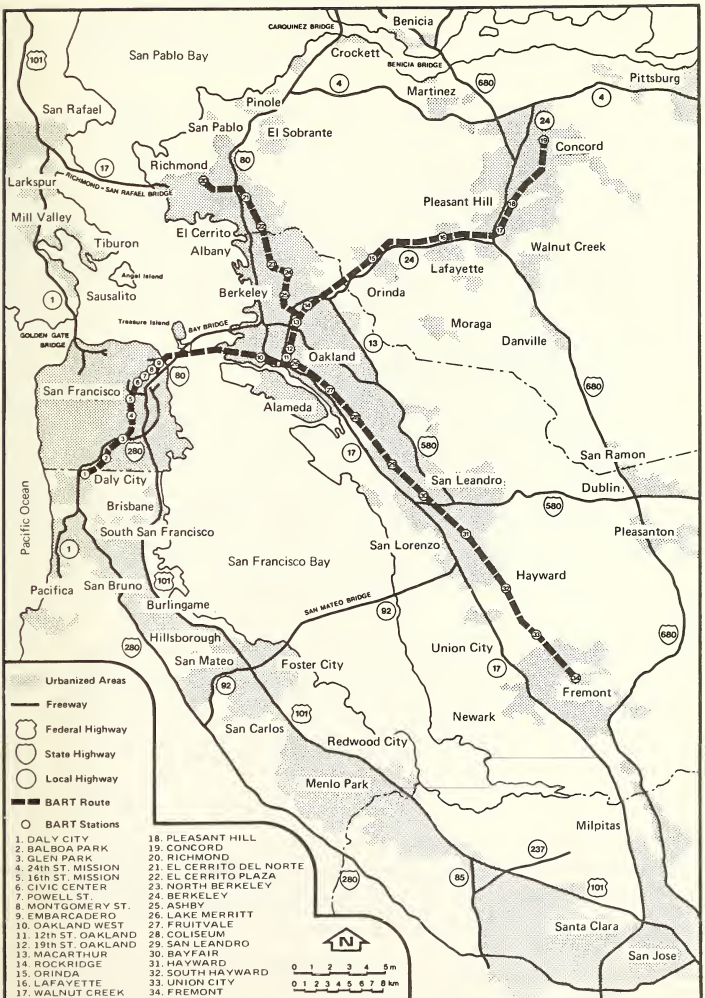


FIGURE 2

BART ROUTE CONFIGURATION AND STATION SPACING

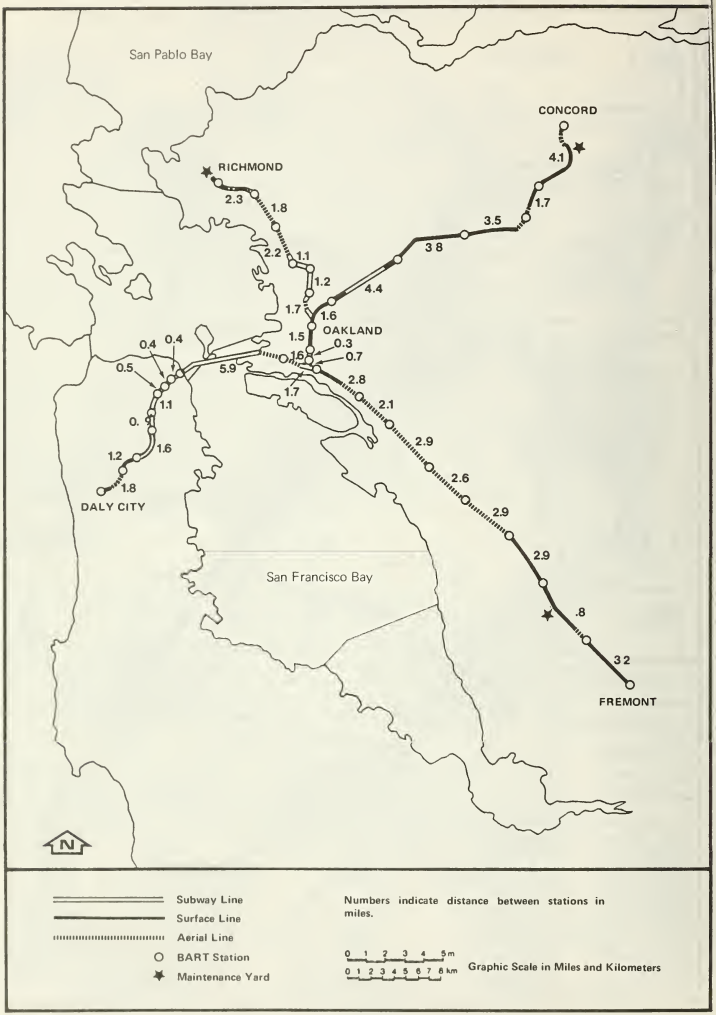


FIGURE 3

The system includes 20 miles of trackway in subway, 24 miles on elevated structures, and 27 miles at ground level. Subway sections are in San Francisco, Berkeley, downtown Oakland, the Transbay Tube, and in a 3-mile long tunnel through the Berkeley hills. (The configuration is illustrated in Figure 3.)

There are 34 stations in the BART system; 8 at grade level, 12 on elevated structures, and 14 in subways. Twenty-three stations have parking lots which range in size from 400 to 1,600 spaces. A total of about 20,000 spaces is provided.

BART was designed to be attractive. For example, the stations were designed by a number of architectural firms to achieve individuality and to harmonize with their settings. Areas around all surface stations are landscaped, and elevated trackway support columns are designed as T-shapes to minimize visual obtrusiveness. A number of street improvement, beautification, and landscaping projects have been developed in conjunction with BART, including linear parks under elevated structures in two locations.

BART stations are less than a half-mile apart in downtown San Francisco and Oakland to provide service within walking distance of central workplace destinations. They are two to four miles apart in suburban areas to permit a high average system speed. The average distance between BART stations is 2.1 miles, greater than that of most metropolitan rail transit systems. The locations of the 34 BART stations and the distances between them are shown in Figure 3.

There are 450 transit cars in the BART fleet. They are unusually attractive and comfortable, and they are equipped with air conditioning, carpeting, and wide, upholstered seats. Each car can carry 72 seated passengers. The trains are two to ten cars in length. They can travel 80 miles per hour, but their maximum speed in ordinary service is 70 miles per hour. Their average speed, including station stops, is 38 miles per hour. The trains operate on a wide-gauge track (5'6") for stability at high speeds.

BART's computerized automatic train operations system supervises the dispatching, scheduling and routing of trains. It regulates train speeds automatically and maintains safe distances between them. It also controls the opening and closing of train doors, the duration of station stops, and the display of information on platform signs. A train operator, who is on board each train, has supervisory duties. The operator can override automatic controls to operate train doors and to stop a train, and can run the train manually (at a low speed) when necessary.

The new San Francisco Municipal Railway light rail system (the MUNI Metro) was built as part of the BART construction project. Its operations are scheduled to begin in late 1979. The MUNI Metro subway will replace the streetcars on Market Street in downtown San Francisco. It will operate above the BART tracks for 1.7 miles, and share the four downtown stations -- Embarcadero, Montgomery, Powell and Civic Center. It

will also include four miles of trackway and four stations beyond the BART line in San Francisco.

BART COSTS

The total capital cost for BART is currently forecast to be $1.636 billion. This includes BART's share of the cost of the MUNI Metro, which is about $155 million.

BART is largely locally financed; about 80% of the total capital cost is from local sources. Forty-nine percent is from bonds which are being repaid from local property taxes. Nine percent was funded from local sales taxes and 11% from tolls collected on the transbay bridges. Another 11% came from interest and other BART earnings. Twenty percent is from federal grants.

THE BART DISTRICT

The California State Legislature established the BART District in 1957. The District has limited jurisdiction, both geographically and functionally. It includes only three of the nine counties in the Bay Area--Alameda, Contra Costa, and San Francisco, the counties in which BART operates. It is empowered only to build and operate a rail rapid transit system. The Act which established the BART District authorized it to issue General Obligation bonds in the amount approved by the voters of the BART counties, and to levy a tax of up to $0.05 per $100 of assessed valuation to cover administrative expenses. The District was given no power to levy taxes to support the operations of the system. (In 1962 when funding for BART was authorized, it was assumed that public transit would cover its operating costs from the farebox.) Since 1974 the State Legislature has authorized a 1/2% sales tax to help support BART operations. Until 1978 all the proceeds from this tax were allocated to the BART District; currently the District receives 75% of the proceeds, and shares in the remaining 25%, which is apportioned by the Metropolitan Transportation Commission (MTC) among the transit operators in the District.

The governing board of the BART District is composed of nine directors, three elected from each of the BART counties.

BUS SERVICE

Local bus service in the three BART counties is provided by two separate agencies, the San Francisco Municipal Railway (MUNI) in San Francisco, and the Alameda-Contra Costa Transit District (AC Transit) in the two East Bay counties. A number of other, separate agencies operate buses in the six counties outside the BART District in the Bay Area. No single authority in the Bay Area was empowered to coordinate transit services when BART was planned. Although local bus operators have provided feeder service to all BART stations, bus services paralleling BART have not been downgraded to the degree envisioned in plans proposed prior to the

beginning of BART service. There is little coordination of schedules, partially because BART operates on a schedule geared to train frequencies rather than a fixed schedule. Nor is there a uniform joint fare or transfer system among the operators in the BART counties. MUNI and AC Transit each have a different transfer system with BART. MTC is now actively engaged in the implementation of coordinated fare and transfer policies for its entire nine-county region.

BART SERVICE

BART operations are relatively new, and they have not yet reached the levels planned for the system. The first line was opened for service in 1972, and service through the Transbay Tube began in September 1974. Currently, BART operates two transbay routes and one route in the East Bay. Trains run every twelve minutes on each route, resulting in six-minute train frequencies in San Francisco, downtown Oakland, and on the Fremont line where routes merge. Planned expansions of BART routes include the addition of one transbay route between Richmond and Daly City. The phased opening of the system is illustrated in Figure 4; current and planned BART services are shown in Table 1.

TABLE 1

CURRENT AND PLANNED BART SERVICES

	Current Services	Date	Planned Services
	Richmond-Fremont	7/73	Richmond-Daly City
	Concord-Daly City	9/74	
	Fremont-Daly City	9/74	
DAYS AND	Weekdays:		
HOURS	6 a.m.-8 p.m.	9/72	
	6 a.m.-midnight	1/76	
	Saturdays:		
	9 a.m.-midnight	1/78	
	6 a.m.-midnight	7/78	
	Sundays:		
	9 a.m.-midnight	7/78	
TRAIN	Daytime(weekday):		Increased peak
FREQUENCY	10-min.intervals	9/72	period train
	12-min.intervals	9/74	frequencies where routes merge
	Evening(weekdays):		
	20-min.intervals	1/77	
	Saturdays:		
	15-min.intervals	1/78	
	Sundays:		
	20-min. intervals	7/78	

Source: BART District Records

BART fares are based on the distance and scheduled speed for each trip. They range from $0.25 to $1.45; the average fare, for an average trip of about thirteen miles, is $0.74. A 90% discount is provided for persons aged sixty-five and over; children five through twelve and handicapped persons receive a 75% discount, and children under five ride free. The automated fare equipment system is illustrated in Figure 5.

BART provides express bus service to outlying areas in Alameda and Contra Costa Counties which are not served by the rail lines or by local buses. (The express bus lines are regarded as extensions of the BART trunkline.) Five express routes, terminating at BART stations, are served by AC buses under contract to BART. Approximately 4,700 persons rode the BART express buses each day in late 1978.

The attributes of BART which have been discussed in this section are the major sources of the impacts described in this report. (A more complete description of the Bay Area and of the BART automatic train operations is included in the appendix to this report.)

PHASED OPENING OF THE BART LINES

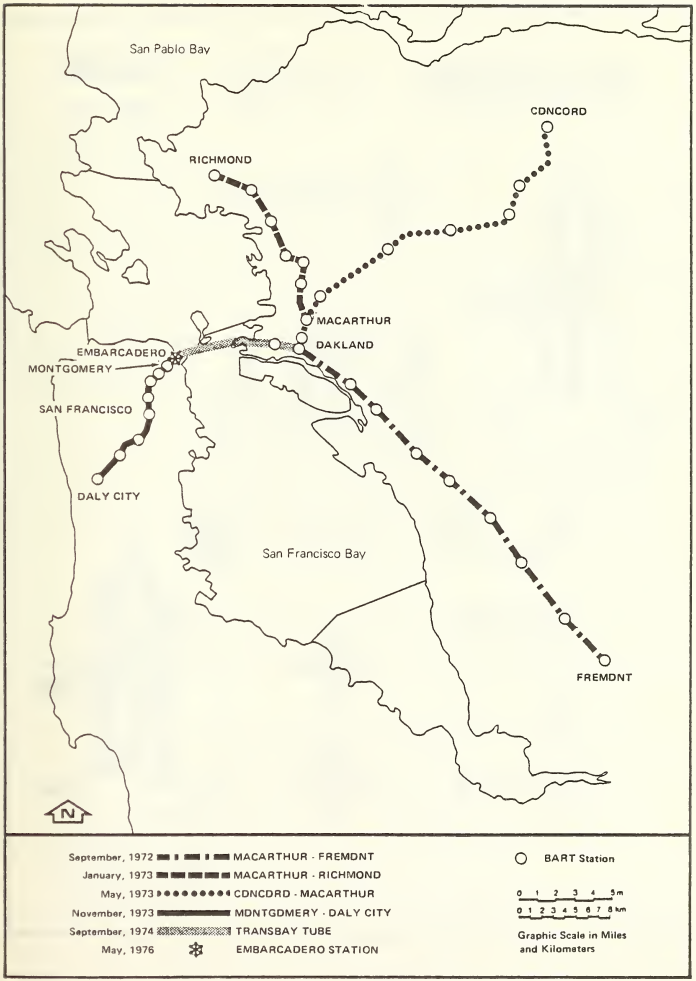
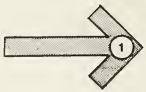
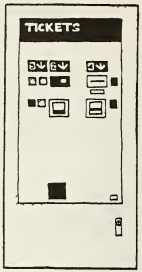


FIGURE 4

STATION ENTRANCE





TICKET VENDOR

Dispenses tickets in amounts from 25¢ to $20.00 in 5¢ increments. (High value BART tickets are also sold at local banks. Discount fare tickets for senior citizens, young people and disabled people are sold only at local banks.)

ENTRY GATE

Accepts tickets and magnetically encodes the time of entry and the station of entry. Permits the patron to pass through and returns the ticket.

TRANSIT SYSTEM

ADDFARE

Adds value to tickets at end of trip if ticket value is insufficient for the trip made.

EXIT GATE

Reads the origin station code. If the ticket value is insufficient the patron is directed to the ADDFARE machine. Otherwise the gate accepts the ticket, deducts the proper fare, and permits the patron to exit. The ticket is returned if value remains.

FIGURE 5

FACTORS WHICH HAVE AFFECTED THE PROGRAM'S FINDINGS

Readers of this report should be aware of the circumstances and the setting in which BART was planned and built and the conditions under which the Program was conducted. An understanding of these factors is critical in interpreting the Program's findings and applying them to other areas.

First, it is important to note that the San Francisco Bay Area has a sound economy, a good system of highways and public transportation, and distinctive land use and development patterns shaped by the Bay and the hills around it. BART was approved and built during a period of vigorous growth in the Bay Area. The economy was expanding, suburban development was burgeoning, and major increments of highway capacity were being added. Also, the Bay Area already had extensive public transportation services. There were public carriers operating dense networks of local transit services on both sides of the Bay, and there was frequent transbay bus service from many parts of the East Bay to San Francisco. All of these factors made it difficult to isolate BART's effects from other influences that were affecting such things as travel behavior and urban development.

A second important point is that BART was planned and designed primarily to facilitate travel from outlying suburbs to downtown areas. Multiple stops are provided in the major central business districts, but in other respects BART resembles a commuter rail system (with long lines and widely-spaced stations) more than a New York or Chicago-style subway system of interlocking crosstown lines and frequent stops. The BART system was intended to rival the automobile in comfort, speed and convenience. Contemporary issues such as energy use, air quality and service for the transportation disadvantaged were not widely recognized and publicized during the period of BART's design.

The institutional setting in the Bay Area was a third important influence on BART's development. BART was developed as a separate institution without full coordination among existing transportation and regional development planning agencies. BART's planners had to make assumptions about future policies and development. Many of these assumptions proved to be contrary to policies ultimately adopted by municipalities in the BART District.

In addition, the fact that BART was not operating at its full service level during the period of study has affected the Program's findings. The frequency of trains, their speeds, the reliability of their operations, and the capacities provided in peak periods of travel by BART were considerably lower than those originally planned. Additionally, it now appears that "full service levels," when they are attained, will not represent the headways and average speeds announced in the original plans.

Finally, BART had been operating for a relatively short time when its impacts were studied. The impact assessment largely depends on data collected in the first four years of BART's operations. It is likely that

some impacts, particularly those relating to urban development, will require more time to mature.

THE CONCEPTUAL BASIS OF THE PROGRAM'S WORK

THE NO-BART ALTERNATIVE (NBA)

The NBA, the transportation system which the Program used as a baseline to evaluate BART's impacts, is a critical factor which has affected the Program's findings. The NBA was developed because a simple comparison of conditions in the Bay Area before and after BART was built would have been misleading. The Bay Area's transportation network would not have remained unchanged if the voters had not approved BART. Therefore, the NBA was developed in an attempt to separate the effects of BART which had occurred by 1976 from those which occurred as a result of factors unrelated to BART.

The definition of the NBA was based on an analysis of the political and financial environment in the Bay Area at the time of the decision to build BART, and in the following years. On the basis of this analysis the judgement was made that the central Bay Area's transportation system in 1976 would have been essentially as it was in 1973, the year prior to the beginning of BART's transbay service. At that time, the bus transit operators were providing higher levels of service than had previously been provided in the Bay Area. Therefore, the system in place in 1973, with some minor changes, was selected as the definition of the NBA. The system consisted chiefly of local and express buses, and it would have provided less service and less capacity than the with-BART system in 1976. It would also have attracted fewer patrons. There would have been very little new capital investment in equipment and facilities.

The year 1976 were selected for comparisons of BART's impacts with those estimated for the NBA because it was a period within the Program's research framework when all of BART's lines had been in operation for at least one year. It does not provide measurements of BART's ultimate impacts, which will be realized only after the system is fully operational.

The selection of the NBA was made after considerable debate, and some transportation experts in the Bay Area continue to question whether it represents the transportation system most likely to have evolved in the absence of BART. The selection was complicated by the fact that BART has been both a cause and effect of forces which have shaped the Bay Area's transportation system. For example, strong concerns on the part of many Bay Area residents for protecting and enhancing the area's economic, social, and environmental attributes resulted in a rejection of proposals for an extensive system of new freeways and highways which were presented in a 1969 Bay Area Transportation Study report. These concerns also resulted in San Francisco's "freeway revolt" in the 1960's which halted the construction of interstate

highways through and around the city. The vote approving BART in 1962 was a result of the same political environment which made the curtailment of freeway expansion possible. BART, in turn, played a causal role in opposition to plans for the "Southern Crossing", a new bridge proposed by the California State Division of Toll Crossings, which was defeated by the voters in 1972. Opposition centered around two issues: (a) environmental concerns for the effects of building and operating the new highway facility; and (b) expectations that BART would provide the capacity to serve increasing transbay travel demand. (The "Southern Crossing" is discussed further in Chapter 2.) Whether the plans would have been approved if BART had not been under construction remains an open question. However, it is clear that BART has been an integral part of the processes which have helped to shape the Bay Area. This has made the definition of an appropriate NBA a complex and difficult task.

The NBA assumptions have had a considerable influence on many of the Program's evaluations and they should be taken into account when the findings are transferred to other urban settings.

THE IMPACT PROCESS

The Program's study of BART's impacts was organized in terms of the impact process, a conceptual chain of events which traces the impacts attributable to BART to the design and operational aspects of the system which cause them. Ultimately the impacts are linked to decisions made in planning and building the system. For example, one BART impact on neighborhoods near some stations was found to be traffic congestion. This impact was caused by BART patrons driving to and from the stations. This cause was then traced to the decision to provide parking lots at most BART stations, and to place the stations and lots in residential areas. Reasons for the absence of traffic congestion in other station areas were also sought. They were traced to decisions to locate parking lots in areas with adequate streets to handle the increased volume, or in areas where pre-existing facilities such as shopping centers had already caused a large volume of traffic in the neighborhood. In such areas the traffic to and from BART stations was not a noticeable problem to nearby residents.

This research process was used to identify and explain the causes of all of the impacts related to BART.

RESEARCH TECHNIQUES

The Program used a variety of methods to study BART's impacts. Because it was a complex and comprehensive study, a long and careful process was required to select appropriate research techniques for the Program as a whole and for each individual component. Choices were made after extensive study and debate. As in any large study, some compromises had to be made. For example, the cost of surveys made it necessary to design them parsimoniously and to sample respondents selectively, with

due regard for accepted sampling techniques. In addition, in some areas of the Program in-depth case studies of selected areas were conducted, rather than general studies of the entire area served by the extensive BART system. In some cases techniques had to be developed or adapted to meet the Program's needs. For example, in order to obtain a complete sound profile of the BART system, a technique was developed for recording sound levels inside the trains and calibrating them to outside monitors.

Despite the compromises and innovations which were necessary, the goal of adopting rigorous research techniques was maintained throughout the Program. The methodology used is documented in the technical reports listed in the bibliography of this report. Over-all Program methodology is discussed further in Appendix B.

The organization of this report is outlined in the next section.

ORGANIZATION OF THE REPORT

The contents of each of the chapters of this report is outlined briefly here, and the Impact Program Projects from which the information in each section has been derived are cited.

The overview and general conclusions sections are interpretations of the results of the work of the Program's various Projects. A summary of the findings in each area is provided at the beginning of Chapters 2 through 8.

The working papers, technical memoranda and final reports of each of the Program's Projects are listed in the bibliography of this report.

CHAPTER 1, INTRODUCTION: The background material provided in this chapter is intended to provide a context to aid readers' understanding of the material in the following chapters. The information in Chapter 1 is from the BART Decision History (Ref. 3), BART District Planning Documents (Ref. 13 and 14), BART District public information material, and from Impact Program memoranda concerning the Impact Process and the No-BART Alternative.

CHAPTER 2, THE IMPACTS OF PLANNING AND CONSTRUCTION: The impacts of planning and building BART described in this chapter include impacts on local community groups, governmental organizations and public agencies; the environmental impacts of the construction process; the land requirements for BART; and the impacts on retail sales of the construction process. The data are drawn from the work of the Impact Program's Environment Project, the Public Policy Project, the Land Use Project, and the BART Decision History (Ref. 3).

CHAPTER 3, DIRECT IMPACTS OF THE BART FACILITIES AND OPERATIONS: The environmental impacts which are direct results of the BART facilities are described. The overall level of impacts and the general categories of the impacts which occur are analyzed. Perceptions of the direct impacts by nearby residents are reported. The findings are the results of work by the Environment Project.

CHAPTER 4, DIRECT IMPACTS OF THE TRANSPORTATION SERVICE: The impacts which result directly from the system's operations are the focus of discussion in this chapter. They include changes in travel patterns, levels of transit ridership, and effects on the highway system and traffic. The major findings are those reported by the Transportation System and Travel Behavior Project.

CHAPTER 5, INDIRECT IMPACTS OF BART'S TRANSPORTATION SERVICE: This chapter describes the indirect impacts of BART's operations on local neighborhoods and residents, and on the energy use and air quality of the region. Responses of residents near BART to the indirect effects of the system in their neighborhood are described. The findings are those of the Environment, the Transportation System and Travel Behavior and the Institutions and Life Styles Projects.

CHAPTER 6, LAND USE AND ECONOMIC DEVELOPMENT IMPACTS: BART's impacts on local land use planning policies and on commercial construction, employment and residence location decisions, residential construction, and on the distribution of population and economic activites in the BART service area are analyzed here. Findings are drawn from the Public Policy Project, the Land Use Project and the Economics and Finance Project. They also include a description of BART's' overall effects on the regional economy, on retail sales, and on property prices and rents in its service area.

CHAPTER 7, THE ECONOMIC AND FINANCIAL IMPACTS OF EXPENDITURES FOR BART: The economic and financial impacts of BART's capital and operating expenditures are analyzed in this chapter. The major findings are those of the Economics and Finance Project. Information about the capital and operating costs of the BART District from the Transportation Systems and Travel Behavior Project is included.

CHAPTER 8, IMPACTS ON SPECIAL POPULATION GROUPS: This chapter summarizes BART's impacts as they have affected minorities, low income persons, and other special population groups. The analysis represents the work of the Institutions and Life Styles Project and the Implications for the Transportation Disadvantaged Project.

SUMMARY AND CONCLUSIONS: The major findings discussed in the body of the report are summarized here.

APPENDIX A, A DESCRIPTION OF BART AND ITS SETTING: The Bay Area and several important attributes of BART are described here.

APPENDIX B, THE IMPACT PROGRAM: The conceptual basis of the Program is briefly described here.

An annotated bibliography listing the Impact Program's published reports and other reports referenced in the Program Final Report is the concluding section.

CHAPTER 2

IMPACTS OF THE PLANNING AND CONSTRUCTION OF BART

SUMMARY

For more than two decades before BART operations began in 1972 the system was a source of impacts in the Bay Area. It provided the impetus for the formation of citizens' groups and affected the activities of local governmental organizations, local transit operators, and the State Division of Highways. Its construction produced impacts on land use and affected the environment in areas near the construction sites. (1)

Both the quality and extent of the planning process are likely to be different for new rail transit systems today, because the federal government has a much more active role and regional planning organizations are more common. No federal funding was available for urban transit systems and no federal policy guidelines or procedures for the planning process were in effect when BART was planned; as a result, the system was largely locally planned and locally financed.(2) Moreover, there was no regional planning authority in the Bay Area, State involvement was largely confined to the establishment of a Commisson to plan the system and a District to build and operate it, and local transit service was operated by separate, sometimes competing transit agencies. As a result there was no mechanism to integrate the plans for BART into a regional transit or land use system.

The BART planning process was also affected by financial constraints and by planners' and local community officials' perceptions of the system's anticipated role in urban development. For example, BART planners and some local officials expected that a major benefit of the system would be its encouragement of high-density, city-centered development around the transit stations. This goal implied that BART facilities would be located in areas with good potential for development. However, some local community groups opposed the placement of the rail lines and stations in their communities' centers of population and commerce on the grounds that BART's facilities and operations would be disruptive. In addition, BART planners were committed to seek least-cost solutions to the placement of lines and stations. As a result, BART was generally placed within pre-existing transportation rights-of-way. Eighty-five percent of the BART mileage lies within, above, or below other transportation rights-of-way. The solution was prudent from a financial point of view and it prevented extensive disruption and environmental impacts. However, in some instances it did not result in the most favorable locations for development or for service to population centers.

BART's planning was further complicated by the fact that there was no regional transportation planning body in the Bay Area until the Metropolitan Transportation Commission (MTC) was formed in 1970. Individual transit operators were involved in negotiations for coordination with BART before and after BART operations began. However, arrangements for feeder bus service to all BART stations and for transfers between BART and buses were not completed until BART had been operating for several years. Even now there is no uniform joint fare among all Bay Area operators, the two major bus operators in the BART counties have separate BART transfer systems, and BART and bus routes compete in a number of corridors. However, MTC and the transit operators

are currently implementing a policy to coordinate fares, transfers and services in the Bay Area.

Highway planning was affected by BART in two ways. First, a highway was widened to accommodate BART trackways and stations. Second, plans for a new bridge across the Bay were opposed by persons concerned about the potential environmental effects of an additional bridge. They argued that BART would provide the capacities to serve the increase in travel demand in the transbay corridor for a number of years into the future. Bay Area voters defeated the proposal in 1972. Although it cannot be determined whether the bridge would have been built if BART had not been under construction, it is clear that the system was a prominent factor in the opposition.

The construction of BART resulted in some disruption and inconvenience to residents and businesses along its rights-of-way, particularly in areas of subway construction. Evidence from a variety of sources provides conflicting impressions of the effects of the construction process on business activity. The sales and patronage of some establishments adjacent to the BART construction site appear to have declined as a result of the construction activities. However, some businesses and some downtown areas do not appear to have experienced any adverse effects which can be attributed to the process of building BART.

Overall, BART's consumption of land and property for lines, stations, and yards was not extensive, and it was far less than that generally required for freeway construction. Slightly more than a thousand acres were acquired, and most of them were undeveloped or already used for transportation purposes. About 3,000 households and 450-500 businesses were displaced. The minimal disruption caused by BART was largely a result of the location of many of its facilities within existing transportation rights-of-way.

BART's construction experience demonstrates that advance planning and coordination with local officials, together with a major public information effort, can minimize adverse impacts and the annoyance with those nuisances that cannot be prevented. It also demonstrates the importance of reducing the duration of construction activities as much as possible to minimize negative impacts.

EARLY PLANNING FOR BART (1949-1962)

THE BART COMMISSION: The first formal organizational steps toward the creation of BART were taken by local business and political leaders in San Francisco, who organized a committee in 1949 to promote rapid transit. Their major concern was traffic congestion and its probable effects on the economic vitality of the area. Congestion in the major corridors was causing inconvenience at that time; on the basis of trends in population, automobile ownership and transit patronage, it was expected to worsen. Population was growing rapidly, automobile registrations were increasing even faster than the population, and transit patronage was declining.

The San Francisco proponents of a new transit system, in concert with representatives of other cities and counties which border the Bay, were successful in influencing the State Legislature to establish a Bay Area Rapid Transit Commission. The Commission, which was established in 1951, engaged the engineering consulting firm of Parsons, Brinckerhoff, Hall and McDonald (PBHM) to study Bay Area settlement and travel patterns and to recommend an appropriate transit plan. PBHM's work was done in the period 1953-1956; it included the development of the region's first land use plan and limited analysis of alternative transit modes. Only a monorail system was evaluated as a possible alternative to heavy rail transit, and it was ruled out on the basis of technical considerations.

The lack of an extensive analysis of alternatives is best understood in the context of the planning environment in the Bay Area in the 1950's. There was no federal involvement in the financing or planning of new transit systems, and therefore there were no federal guidelines for such an analysis. Moreover, there was widespread acceptance of rail transit as an alternative which seemed well suited to the Bay Area. The lines and stations could be located in topographically-constrained transportation corridors which defined the areas of regional growth, and the system could operate under the Bay and underground in downtown city areas. Buses, by contrast, were considered to be outmoded, uncomfortable, and incapable of operating at speeds which could attract motorists from their cars.

Rail transit suited the preferences of a large segment of Bay Area residents who opposed further bridge and highway construction because it was considered detrimental to the Bay Area's valued visual and environmental amenities. Activities and events in the Bay Area before, during and after the planning of BART demonstrate the widespread support for protecting the quality of the area. For example, extensive areas have been reserved for parks, stringent regulation controls further filling of the Bay, and a commission has been established to regulate coastal development. The "freeway revolt" in San Francisco in the 1960's was a dramatic example of the political strength of conservation forces. This effort halted the construction of interstate highways through and around

the city, and left dead-end stubs on partially completed elevated freeways as unique features of the San Francisco landscape.

PBHM's report to the Commission in 1956 supported the opponents of freeway development. (3) The consultant recommended a heavy rail system to extend throughout the nine counties of the Bay Area.

THE BART DISTRICT: The publication of the PBHM recommendations ended the work of the Commisson; it was replaced by the BART District in 1957. The District represented only five counties, rather than the nine originally planned, and by 1962 it had been reduced in size to the three central Bay Area counties of San Francisco, Alameda, and Contra Costa. The three sparsely settled, largely rural northern counties had been excluded from the first phase of the District's work because the tax base in that area was insufficient to cover the cost of building the system there. Their inclusion would have required subsidies from the more extensively urbanized counties, a politically unacceptable alternative. Two other counties asked to withdraw from the District largely because of opposition to higher taxes from business and agricultural interests within the counties. Marin County, across the Bay to the north of San Francisco, was then asked to withdraw for two reasons: (a) questions were raised about the structural adequacy of the Golden Gate Bridge to support the rail system; and (b) the tax base of the shrunken district was insufficient to cover the costs of building the system in Marin, which had a relatively sparse population and little industry or commerce. As this aspect of the BART experience demonstrates, the cost of rail transit is difficult to justify in sparsely-settled areas, and attempts to subsidize the costs from taxes levied elsewhere are likely to create political opposition. (The shrinking of the BART District is described more fully in Ref. 3.)

The engineering consulting firm of Parsons Brinckerhoff - Tudor-Bechtel (PBTB) was selected by the District to prepare detailed design, engineering and financial plans for the new rail system. Both the PBTB engineers and BART District officials agreed that the new system would have to compete on favorable terms with automobiles if motorists were to be lured from their cars. The qualities considered necessary to accomplish this included short travel times between departure points and destinations;modern, safe, comfortable equipment; and adequate, convenient and low-cost (preferably free) parking facilities at suburban stations.

Speed, comfort and convenience were the goals for system performance which were translated into design specifications for BART. Other considerations which influenced the decisions included the need to find least-cost solutions to design and construction problems and to respond to local jurisdictions along the BART routes. Because BART was locally funded, it was necessary that local needs and desires be seriously considered. The BART District Act, passed by the State Legislature in 1957, required that the BART District officers hear any local requests for changes in the location of system facilities.

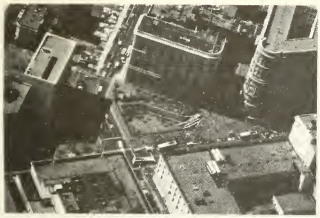
The conceptual basis for route selections reflected the general goals for the system; BART was to supplement existing highway capacities, connect

urban subcenters to the major metropolitan areas, and serve existing and projected patterns of travel and growth. Since virtually no land use planning capability existed in the local communities to be served by BART, PBHM had formulated its own land use plans and projections based on existing travel patterns. In many areas around the Bay natural travel corridors had been defined by the hills and by the Bay itself, precluding a consideration of alternative routes. As a result, BART was planned to be placed adjacent to existing highways or in the medians of planned freeways which themselves were located in existing travel corridors. The decision to place the lines and stations in pre-existing travel corridors was reinforced by the desire to find a least-cost solution to the location problems.

In at least one instance this solution was not the most favorable in terms of providing access to major population and activity centers, and in terms of development potential; the Fremont Line in Oakland was placed beside a railroad, at some distance from major concentrations of population. This decision resulted in part from local fears that BART would be disruptive, and in part from poor coordination among agencies planning Bay Area transportation facilities. In the early 1950's BART's planners had sought a route through population centers in Oakland and San Leandro. However, the attitude of the local officials was that BART, as a railway, should be placed down along the Bay with the other railroads. Ironically, after the decision had been made to accede to that wish, the MacArthur Freeway (I-580) was placed in an easterly corridor that divides the cities in the way that local officials had feared the BART trackway would do. By the time the BART bond issue was passed the freeway construction was so far along that it was no longer possible to place a BART structure in its right-of-way.

Unfortunately, the route through Oakland and San Leandro is not in an area which is attractive for new developments. The BART stations outside the downtown district do not generate substantial patronage. In the areas surrounding several of them there is little commercial activity, nearby housing is deteriorating, and some are isolated from activity centers by areas of land-intensive light industry, freeway structures, and railroad tracks.

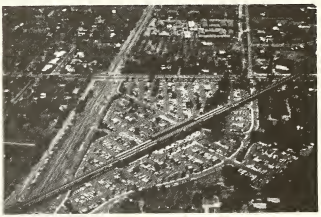
Other decisions provided better service and development potential for BART. In San Francisco, BART lines were located along the Market Street transit spine, and extended into residential areas. The Concord and southern Fremont lines are in growing residential areas. Richmond line stations, in general, serve older residential areas and the downtown city center in Berkeley. In two cases routes and stations were placed in small communities in largely rural areas. Both Walnut Creek, on the Concord line in Contra Costa County, and the City of Fremont, the terminal station of the Fremont line in southern Alameda County, were identified by BART planners as areas of potential growth. Both have become important subcenters, as the planners forecast. (The land use impacts of BART to date are discussed in Chapter 6.)



1. CENTRAL DOWNTOWN
POWELL ST., SAN FRANCISCO

2. COMMERCIAL SUB-CENTER
EL CERRITO PLAZA

3. URBAN RESIDENTIAL
NORTH BERKELEY



4. SUBURBAN RESIDENTIAL
PLEASANT HILL

5. INDUSTRIAL/COMMERCIAL
COLISEUM, OAKLAND

6. OPEN LAND
CONTRA COSTA COUNTY

BART LAND USE SETTINGS

Decisions about the system's configuration were based on engineering, financial and environmental considerations. Surface construction was the most economical and was used for 27 miles, primarily in low density suburban areas. Elevated tracks were used for 24 miles in higher density areas wherever a considerable number of grade-separated crossings were needed and where land was more costly. Subways were built in the urban centers due to the high cost of the land and the obtrusiveness of above-ground lines.

Engineering and financial plans for the three-county BART system were completed by PBTB in 1962. The consultant's "Composite Report" was the basis on which voters were asked to authorize funding for the system. The business leaders who had promoted BART rallied to help convince voters to support the bond issue and to persuade the State Legislature to reduce the margin of approval required for its passage. Their efforts were successful; legislation was enacted just prior to the vote in 1962 to lower the requirement of a 66 2/3% majority vote for approval to 60%. In November, 1962, 61% of the voters of the three counties approved the $792 million bond issue for the construction of BART.

FROM PLANNING TO IMPLEMENTATION (1962-72)

The involvement of business leaders with regional BARTD issues largely ceased with the passage of the bond issue. Local communities and state, regional, and local planning and operating agencies were the groups involved with BARTD planning after 1962.

IMPACTS ON LOCAL COMMUNITIES: Local governments responded to the passage of the bond issue by seeking to minimize the costs and maximize the benefits to their communities of alternative route alignments and station locations. Boards of Supervisors, city councils, mayors, and city managers negotiated with the BART District to obtain all possible benefits from BART's construction, including local street improvements, grade separations of existing transportation facilities, and station and line placement. The result was the re-routing of fifteen miles of the seventy-one mile system, and the relocation of sixteen of the thirty-four stations from the locations specified in the 1962 "Composite Report." BARTD executed over 166 agreements with cities, counties, special districts, railroads and the State Division of Highways.

The process resulted in some temporary and limited changes in governmental structures and operations at the local level. In some municipalities business and neighborhood groups negotiated for programs and thus became involved in the decision-making process. In some city governments, transportation-management, planning or other personnel were assigned to interface with BART officials and staff.

In San Francisco there was considerable community and corporate concern about the future vitality of the downtown area in the late 1950's and early 1960's. When the BART system was approved by the voters, San Francisco business and civic groups organized a Market Street Development Association to promote public improvements in conjunction with the new transit stations. The result was a $35 million beautification project

which changed the character of Market Street and made it an attractive location for businesses.

In urban residential areas early projections of substantial BART land use impacts raised both expectations and fears of potential residential and commercial development impacts. For instance, in areas near the two Mission District stations in San Francisco and around the Rockridge station in Oakland community groups organized to fight for downzoning of their neighborhoods to prevent intensive commercial and residential developments. In both cases, coalitions of residents and small merchants organized in response to expectations that BART-related developments would disrupt the quality and integrity of community neighborhood life. Both groups successfully achieved the goal of downzoning the neighborhoods.

IMPACTS ON REGIONAL AND STATE AGENCIES: Since the 1960's a number of agencies which represent a new regional and state-wide approach to transportation planning have been created in the Bay Area. These include the Metropolitan Transportation Commission (MTC), the California State Department of Transportation (CALTRANS), and the Association of Bay Area Governments (ABAG), which conducts land use planning programs. BART was not the single cause of the formation of these agencies, but it was one of a number of independent transit operations which contributed to the recognition of a need for regional planning. BART has had a marked effect on the role of only one of these agencies, MTC. MTC was established in 1970 by the State Legislature to provide a comprehensive, regional approach to transportation planning in the nine counties of the Bay Area. BART has contributed to a more prominent focus on operations performance evaluations within the agency, in response to the State Legislature's requirements for justification for BART funding. However, this occurred in a climate in which the federal and state governments were increasingly making transportation subsidies for all operators contingent on efficient operations.

IMPACTS ON STATE HIGHWAY PLANS: One important expectation among BART planners was that the system would reduce or eliminate the need for additional highways and bridges in its service area. The anticipation of BART service did play a role in defeating a proposal for an additional bridge with an extensive system of access streets and highways. In the 1960's the State Division of Toll Crossings had advocated the construction of a new bridge, called the "Southern Crossing", to link San Francisco and Oakland just south of the existing San Francisco-Oakland Bay Bridge. Strong opposition developed to the plans, and the argument "Let's give BART a chance" was repeatedly used in the debate. Concerns for the environmental effects of its construction and its use by increasing numbers of motorists played a prominent role in the debate. The bond election was held in 1972, and the plan was defeated. Whether the new bridge would have been built if BART had not been under construction cannot be judged with certainty.

BART caused few changes in other state highway plans. Route 24, a freeway leading to central Oakland and providing access to downtown San Francisco from Contra Costa County received funds for widening and

improvements only because of plans to place BART in the median strip. Its construction schedule was expedited to coincide with the construction of BART. Therefore the expanded highway capacity in this corridor can be considered to be a BART impact.

IMPACTS ON LOCAL TRANSIT OPERATING POLICIES: Service coordination with existing transit operations is critically important to a system such as BART which provides the line-haul transit service in the regional transportation network. Full coordination of services, fares and transfers between BART and buses has not yet been achieved, however, largely because transit operators in the Bay Area are separate, sometimes competing agencies.

Both before and after BART construction began studies were conducted to identify coordination needs, and numerous negotiations took place between the BART District and the two major local transit operators in the BART service area, AC and MUNI. Route alterations have been made to provide feeder bus service to all BART stations. However, the feeder service at some stations is infrequent, and BART and bus schedules are not coordinated. (BART operates according to headways, or intervals between trains, rather than a time schedule. This practice and the lack of service reliability have made service coordination with other systems difficult). The transfer arrangements between BART and AC and between BART and MUNI are different. A fully coordinated transfer system between all Bay Area transit operators has not yet been implemented, although efforts are currently underway to provide such arrangements. (BART's impacts on local transit services and ridership are described in Chapter 4.)

THE IMPACTS OF BART'S CONSTRUCTION: 1964-1973

The effects of the physical process of building a rapid transit system are generally the first impacts to be experienced by residents in the service area. They include impacts on the environment and the persons and businesses near the construction sites, as well as impacts resulting from the consumption of land for the system's facilities.

LAND ACQUISITION

About 7,000-8,000 persons and 450-500 businesses were displaced for the construction of the BART facilities. While these were major impacts for the persons affected, they were minimal in comparison to the number of persons displaced for freeway construction. For instance, the three-and-one-half mile Grove Shafter freeway in Oakland (Highway 24) displaced 3,000 households. All but 100 of them would have been displaced even if the freeway had not been widened to accommodate the BART system in its median.

The total amount of land acquired by BART was 1,100 acres. This amount, and the displacement it caused, was minimized by the fact that much of the system was located within or adjacent to existing freeway and other railroad rights-of- way. Over 60% of the land purchased by the District was undeveloped or was being used for other transportation purposes. The BART right-of-way rarely exceeded seventy-five feet in width; by contrast, an eight-lane freeway requires at least a 120-foot right-of-way.

Records of the relocation process are incomplete because BART did not provide relocation assistance until after 1966, when half of the parcels had been acquired. Overall, 441 residential relocation payments (generally $50 per bedroom up to $250) were made to a total of 1,281 persons. Moving expenses up to $3,000 were paid to 257 small businesses.

The BART District had to purchase some land that was not actually needed for the rights-of-way; however, the quantity was small. Only 86 acres were classified as surplus. Until the spring of 1977 BART policy was to retain this surplus property in areas where development and an appreciation in value was anticipated. In March 1977, the policy was changed to one calling for the disposal of all remaining surplus land. Ultimately the responsibility for planning the re-use of surplus properties rests with local governments. A transit district can participate in joint corridor planning efforts, but it cannot, under current California law, become an active developer.

THE ENVIRONMENTAL IMPACTS OF THE CONSTRUCTION PROCESS

The impacts which were caused by the construction of BART varied in severity from the inconvenience to nearby residents of dirt, noise, and

obstructions in streets to the disruption of business activities because of impeded access to customers. The major construction activities were completed before the Impact Program began; therefore construction impacts have been studied retrospectively from newspaper articles, BART's files, and interviews with BART contractors, residents, and representatives of businesses near construction sites. As might be expected, the severity of the impacts at a construction site depended on the kind of structure being built; for instance, cut-and-cover subway construction created more adverse impacts over a longer period of time than did the construction of at-grade or elevated facilities.

SUBWAY CONSTRUCTION: BART lines in downtown San Francisco and Oakland were tunneled. All subway stations and the line through most of the City of Berkeley were built by cut-and-cover construction. The duration of the subway construction was generally appreciably longer than that of above-ground construction. For this reason, and because subways were generally built in heavily traveled areas, the potential for extensive disruption was greatest at the subway construction sites.

The construction was most prolonged in downtown San Francisco, where it lasted up to five years and included several phases: re-mapping and relocation of utilities, the construction of three stations and the underground lines, the modification of stations to lengthen their mezzanine areas in response to requests from the City, the building of Embarcadero station after much of the construction of the other downtown stations had been completed, and the street beautification project which was undertaken in conjunction with BART.

Building subway lines by tunnelling was much more expensive than cut-and-cover construction, but it produced few adverse impacts. Cut-and-cover construction, by contrast, inconvenienced vehicular and pedestrian traffic to a considerable degree. Usable street widths were reduced for excavation and the storage of materials. Bus and trolley stops were relocated, and in some areas traffic was re-routed. Retaining walls were placed against buildings where streets were narrow, and temporary wooden walks replaced sidewalks.

CONSTRUCTION OF SUBURBAN STATIONS AND ABOVE-GROUND LINES: Lines and stations in suburban areas were built at-grade, on earth embankments, or on elevated structures. This construction produced far fewer impacts than the subway construction in the central cities. Most suburban stations were built in relatively quiet areas with little traffic, and the most disruptive period of construction at suburban sites averaged about six months. Construction of elevated and at-grade lines was minimally disruptive and the period of major disruption very short--about two months for elevated lines, and a matter of weeks only for at-grade lines. Nevertheless, a 1976 Impact Program survey (Wayside Survey) found that a majority of persons who lived in the first row of houses adjacent to construction sites of suburban stations and elevated lines remember the process as one which had adverse effects on their neighborhood.(4)

EFFORTS TO MINIMIZE IMPACTS: A number of measures taken by BART mitigated the adverse effects of the construction activities. Access to all buildings was maintained at all times throughout the process. Traffic

problems were addressed in an extensive pre-construction coordination process between BART and city officials. Traffic control systems were developed to minimize safety hazards and impediments to traffic flow. Some downtown Oakland streets were made one-way to simplify the traffic flow through the construction sites. The placement of construction materials around the sites was limited to the space available in one traffic lane. Timbers were installed over station openings to allow traffic movement over the stations after the initial excavation work. Cut-and-cover construction was scheduled for daytime hours only, sonic pile drivers were used and special vaults were built to house heavy construction machinery to minimize the noise impacts. As a result, the noise impacts of cut-and-cover construction in downtown areas were minimal.

BART staff and contractors undertook an extensive public relations program at each construction site. Contractors checked with nearby merchants from time to time to identify problems and to improve conditions wherever possible. Engineers sometimes visited complainants to observe reported problems and to review the complaints. Residents near construction sites were invited to meet with the contractors for an explanation of the construction process and its probable effects in their neighborhoods. The knowledge that disruption would occur for a limited and predictable length of time and that efforts were being made to limit its effects appeared to help minimize the annoyance with nuisances which could not be prevented, in the judgment of the persons involved.

CUT-AND-COVER CONSTRUCTION
DOWNTOWN, SAN FRANCISCO

AERIAL LINE CONSTRUCTION
WALNUT CREEK

IMPACTS ON RETAIL SALES

Because the construction activities in downtown areas impeded pedestrian and vehicle traffic they could be expected to affect retail businesses in the downtown areas. However, existing data do not provide a clear indication of the pattern and extent of the effects. For instance, merchants report contradictory impressions of the impacts of building BART on retail sales. Overall, about half of those interviewed reported that their sales had declined during the period of BART construction. Among those reporting a decline, about half identified the BART construction activities as the cause. Those reporting declines were merchants near cut-and-cover construction sites in the central cities. Retailers in suburban locations rarely reported being affected by the construction activities. The factor cited most frequently as the principal cause was the inconvenience to travel in the downtown area. The loss of visibility from the street, caused by the retaining walls, was also cited, but less often. The temporary environmental effects associated with the construction activities were cited as a cause of lost sales even less frequently.

Sales tax data sampled for retail stores in downtown San Francisco, Oakland and Berkeley are also somewhat ambiguous in their evidence of BART's construction impacts on businesses. Large stores within 400 feet of the construction sites lost sales during the construction period, but similar stores beyond the immediate area of the construction also experienced declining sales. The decline during the construction period was greater for stores near BART; during the post-construction period sales continued to decline more for stores near BART, on the average. Because comparable data for the period prior to 1970 are not available, it cannot be established whether stores near BART were less prosperous than others before construction began.(5) The sales tax data for large stores, in terms of average annual percentage change during selected periods, are shown in Table 2.

TABLE 2

AVERAGE ANNUAL PERCENTAGE CHANGE IN TAXABLE RETAIL SALES PER STORE BY DISTANCE FROM BART (6)

	All Stores	Large Stores: Within 400 Feet of BART Station		Large Stores: Beyond 400 Feet of BART Station	
	Pre Construction*	During Construction**	Post Construction***	During Construction**	Post Construction***
San Francisco	-0.5	-3.9	-2.4	-2.7	3.0
Oakland	-2.9	-7.8	-2.9	-2.6	-2.9
Berkeley	1.7	-4.6	-1.7	1.3	3.1

*1963-1967 Figures apply to the entire CBD and are not necessarily comparable to the sales tax figures for later years.
**1970-1972 for downtown San Francisco; 1970-1971 for downtown Oakland and Berkeley.
***1972-1976 for downtown San Francisco; 1971-1976 for downtown Oakland and Berkeley.

Source: Ref. 4

Sales declines diminished for stores in all three areas after construction had ended. This might indicate that shoppers who had ceased to patronize the three downtown areas before and during BART construction had begun to return. This explanation is consistent with other evidence which suggests that BART is having an effect on shopping patterns, especially in downtown San Francisco and Oakland. This evidence is discussed in Chapter 6.

Sales tax data for small stores, shown in Table 3, indicate that stores near BART construction sites in Oakland and Berkeley experienced increases in sales during the BART construction period, on the average. In both Oakland and San Francisco the average growth in sales near BART construction sites was greater than for small stores farther away (or declines in sales were smaller). A possible explanation could be that marginal stores closed, raising the overall sales-per-store average. However, none of the areas experienced increases in sales (or diminishing declines) after the construction period.

TABLE 3

AVERAGE ANNUAL PERCENTAGE CHANGE IN TAXABLE RETAIL SALES PER STORE BY DISTANCE FROM BART (7)

	All Stores	Small Stores			
		Within 400 Feet of BART Station		Beyond 400 Feet of BART Station	
	Pre Construction*	During Construction**	Post Construction***	During Construction**	Post Construction***
San Francisco	-0.5	-2.7	-5.5	-4.3	-3.2
Oakland	-2.9	9.1	-6.0	-4.3	-2.7
Berkeley	1.7	1.6	-5.3	11.7	-1.8

*1963-1967. Figures apply to the entire CBD and are not necessarily comparable to the sales tax figures for later years.
**1970-1972 for downtown San Francisco; 1970-1971 for downtown Oakland and Berkeley.
***1972-1976 for downtown San Francisco; 1971-1976 for downtown Oakland and Berkeley.

Source: Ref. 4

NEWSPAPER ACCOUNTS: Newspaper reports of the construction impacts of BART on nearby businesses were contradictory, as shown by the following examples:

- In April 1968, more than a dozen merchants whose businesses were located on Market St. between Sansome and New Montgomery complained to the Board of Supervisors that their sales had fallen considerably since the onset of BART construction. They contended that their stores were hidden behind barricades, that the sidewalks were narrowed to such a degree that it was difficult to pass, and that pedestrian traffic had been reduced by fifty percent. They requested lower barricades, more transit stops, new pedestrian crossings, or temporary tax relief.(8)

- The owners of small businesses along Market Street denounced BART construction activities in 1970 for lowering their sales and hampering day-to-day operations such as making deliveries.(9)

- An article in the San Francisco Examiner (August 11, 1968) stated that the large decline in the downtown's retail sales that had been predicted had not materialized, and that business was at least as good as in pre-construction days.

. Paul Ryan, manager of the S.F. Board of Trade, acknowledged in late 1968 that business along the BART line was depressed, especially near the sites of major underground work. But he claimed there had been fewer closings during the past year than in previous years. Higher interest rates were cited as a potentially greater cause for the depressed retail activity than BART construction.(10)

A number of factors might account for the discrepancies. For instance, it is possible that small firms might be particularly sensitive to any disruption threatening their trade. Stores relying heavily on impulse buying and off-the-street trade would probably suffer more than other merchants. Establishments which serve other businesses, rather than consumers, those providing unusual services or selling unique or expensive merchandise might have been less affected by disruptions in travel patterns.

IMPACTS OF BART'S CONSTRUCTION ON NEW DEVELOPMENT AND REHABILITATION

BART construction activities did not in any way deter the construction of new offices or other buildings; office construction in areas near planned BART facilities increased after the BART construction activities began. It appears that before ground was broken for the system many developers were skeptical that BART would be built and they were reluctant to commit themselves to new projects. When construction began a number of new office developments were started. During the five-to-seven years before the beginning of BART's construction, fifteen permits were issued for new office buildings within 150 feet of BART in the cities and counties in its service area. During the three-to-seven years of the construction period, twenty-two permits were issued. Thirty-five permits were issued for additions and alterations to offices within 150 feet of BART in the years preceding the construction, and fifty-one permits were issued during the construction period.

Similarly, there is no evidence that the BART construction activities caused housing developers to delay or eliminate new housing construction. New housing projects were begun while BART was being built, timed so that their opening would coincide with the scheduled beginning of BART service. This implies that any temporary negative factors which might have been associated with the BART construction project were outweighed by the anticipation of advantages from BART's service.

FOOTNOTES TO CHAPTER 2

(1) The discussion of the impacts of construction activities on land use in this chapter refers only to impacts resulting directly from the construction process and the acquisition of land for BART facilities. Impacts on local land use zoning and planning are discussed in Chapter 6.

(2) The first federal funds for the capital costs of the system became available to BART in 1964 for the construction of a test track. In 1966 the federal government began to make funds for the capital costs of urban transit systems available on a regular basis. Currently 20% of the capital costs of BART have been federally funded.

(3) Ref. 13, p.106.

(4) Ref. 21.

(5) The sales tax data collection did not begin until 1970, well after much of BART's heavy construction was underway. Other information from the pre-BART construction period cannot be stated in terms of distance from BART or in terms of large and small stores.

(6) Source: Sales tax data collected by the California State Board of Equalization for sampled stores in the BART service area. Large stores are defined as those with $500,000 or more in annual sales. Small stores are those with less than $500,000 in annual sales.

(7) Ibid.

(8) "Market Street Merchants Seek BART Relief," San Francisco Chronicle, April 18, 1968.

(9) "BART Chaos Hurts Firms," San Francisco Chronicle, October 26, 1970.

(10) San Francisco Examiner, September 22, 1969.

CHAPTER 3

DIRECT IMPACTS OF THE BART FACILITIES AND OPERATIONS

SUMMARY

The BART system includes twenty-four miles of elevated trackway, twenty-seven miles of trackway at grade level or on an embankment, thirty-four stations and twenty-three parking lots which have a total of about 20,000 spaces. Such a massive and extensive project has the potential for substantial adverse environmental impacts on the areas through which it passes. Nevertheless, BART's overall effects on the environment are primarily neutral. The system was integrated into the Bay Area with minimal environmental disruption by careful planning and by placing most BART facilities within or adjacent to other transportation rights-of-way. The degree to which impacts occur, and the responses to them, vary throughout the system. However, the environmental impacts are small enough in most places to require careful study even to detect.

The impacts which have been produced are largely confined to the neighborhoods and streets directly adjacent to the lines and stations. The most frequent sources of impact are the visual appearance of the facilities and the sound of moving trains. Train noise problems occur along about 10% of the line and are confined to a narrow band, but are significant to many of the persons whose homes are in the areas of impact. Although the trains are quiet compared to most other rapid transit vehicles now in use, their high speeds, particularly on elevated trackways, generate sound which exceeds background levels in quiet neighborhoods.

Relatively few persons are affected by BART's adverse environmental impacts, and those who are affected generally responded indifferently rather than negatively or positively when they were asked their opinions about the overall impacts of the system.

The BART experience shows that a rapid transit system's environmental impacts need not be large. Adverse environmental impacts are largely avoidable through careful facility location and physical design. Specific ways of doing this, and of estimating the outcome during planning, can be demonstrated from BART's experience. Such findings permit informed trade-offs of environmental considerations with other factors such as cost, displacement of persons and businesses, travel time, and the location of facilities in relation to the population to be served.

The impacts of BART's facilities and operations were studied in a variety of ways, ranging from interviews with geologists and naturalists to instrumented measurements of sound levels along the BART right-of-way. Perceptions of the persons who live near the facilities were measured in a survey conducted in 1976.(1)

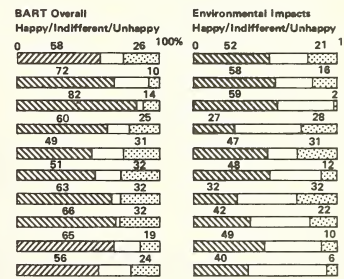
RESIDENTS' RESPONSES TO BART'S OVERALL IMPACTS

The persons most directly and continuously exposed to BART, those who live within a few blocks of its lines and stations, were surveyed in interviews conducted in neighborhoods within one to four blocks of 3 station and 7 trackway sites. The respondents were selected by means of a statistical sampling plan at each of the survey sites. Their responses are generally favorable, as shown in Figure 6.

The responses shown in the first column of Figure 6 represent perceptions of the BART system in general--its service, costs, and its environmental and social impacts. Over half of the respondents at all but one site (Albany West, where the proportion was 49%) reported being happy about BART, in general. Overall, less than one-third reported general dissatisfaction with the system. Even among persons living near the Daly City Station where BART operations caused increased traffic and parking on neighborhood streets, less than 10% said they were unhappy with BART, in general.

FIGURE 6

GENERAL RESIDENTIAL SURVEY RESPONSE TO BART



*S = Station, AL = Aerial Line, GL = At-Grade Line

Source: Ref. 21

The responses shown in the second column of Figure 6 represent perceptions of the environmental impacts specifically, rather than perceptions of the system as a whole. They indicate that a majority of the residents near the BART stations are happy with the environmental impacts, but that persons living near the BART trackways, particularly elevated trackways, are more frequently unhappy with this aspect of BART's impacts. Further questioning indicated that the major problem is the noise generated by BART trains.

VISUAL IMPACTS

BART is a familiar sight to travelers in its service area. The station structures, the above-ground lines, the directional signs showing station locations, and the moving trains are visible indications of its presence.

A majority of the persons surveyed regarded the appearance of the BART facilities as assets to their neighborhoods, or they reported feeling indifferent toward their appearance. Their perceptions in this matter differed from those of urban design professionals who evaluated the visual quality of the system, and who judged BART stations, parking lots, and trackway structures to be incompatible in scale with their surroundings in low-density urban or suburban residential neighborhoods.

Both the urban designers and persons living near BART facilities judged landscaping to be an important means of softening the appearance of all the BART facilities.

VIEWS OF BART

AERIAL LINE.

STATION EXTERIOR.

Landscaping was judged to be particularly important in the successful integration of stations and parking lots in residential areas. In addition, the deliberate design of stations to be inconspicuous and to harmonize with the scale of nearby buildings was judged to be important. The urban designers gave highest ratings to relatively small stations which use backyard fences rather than streets as parking lot boundaries, and which have several small lots rather than a single large lot. These stations do not have barren stretches of concrete which clash with the surroundings.

The responses of residents near the BART facilities to the visual impacts of the system are shown in Table 4.

TABLE 4

RATINGS OF BART'S VISUAL IMPACTS ON THE APPEARANCE OF NEIGHBORHOODS(3)

Sites:	Percent of Responses		
	"Good"	"Indifferent"	"Bad"
STATION:			
Concord	11	64	25
Daly City	40	44	16
El Cerrito	36	60	4
ELEVATED LINE:			
Albany E.	14	71	15
Albany W.	40	42	18
Oakland	40	48	12
Hayward N.	4	76	20
San Leandro	10	67	23
AT-GRADE LINE:			
Richmond	10	84	6
Hayward S.	10	88	2

Source: Ref. 21

Indifferent responses (neither positive nor negative) range from 42% at Albany West to 88% at Hayward South. Negative responses range from 23% at San Leandro to 4% at El Cerrito Plaza. The most positive responses are from residents around the Daly City Station and the elevated lines in Oakland and Albany West. The professional assessment rated the visual impact of the Daly City Station highly because it separates visually incompatible land uses -- a freeway and an area of homes. (A similar visual function is served by the Bay Fair Station, which is between a shopping center and an area of homes.)

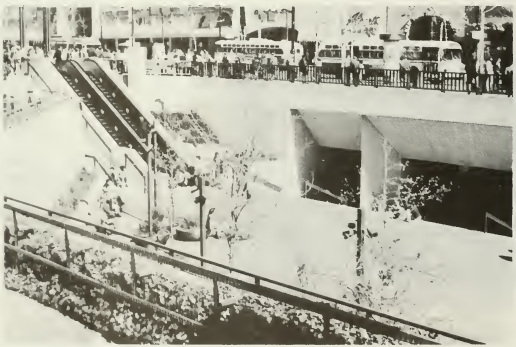
The positive response among residents at the Albany West site is attributable to the orientation of the homes; they face a linear park

under the elevated BART structure and are separated from the trackway by a street. Residents in the homes on the east side of the track (the Albany East site) responded much less favorably. These homes are separated from the BART line only by backyard fences.

The importance of landscaping is underscored by the responses of residents at the Oakland, Hayward North, and San Leandro sites. At the Oakland site, where the elevated line is in the median of a wide traffic artery, nearby residents responded favorably to BART's visual impacts. The median strip under the structure is landscaped. By contrast, the most unfavorable ratings of BART's visual impacts were from persons living near the two elevated line sites -- Hayward North and San Leandro -- where there is no landscaping.

The extensive lighting at BART stations and parking lots was judged by the technical assessment to be a potential problem to nearby residents. However, most nearby residents were indifferent to the lighting, and substantial numbers considered it to be helpful as a protection against crime and accidents.

Views from homes in some residential areas have been adversely affected by BART's elevated and at-grade trackway. Up to half the residents surveyed whose homes were in the first row facing BART felt that BART harmed their view. In addition, shadows tend to create adverse effects in areas where the elevated line is very close to residential structures and yards. On the other hand, visual improvements have accompanied the BART lines in some areas. The most notable example is a 2.7-mile linear park along the elevated trackway in Albany and El Cerrito. The park consists of a landscaped meandering walkway and features play lots and seating areas. (A similar 0.5-mile park is along the BART structure in Walnut Creek and Pleasant Hill.)



ENTRANCE TO POWELL STREET BART STATION

LINEAR PARK IN WALNUT CREEK

BART trains have not resulted in significant noise around stations, largely because they slow and stop quietly. They decelerate over a 2,000 foot track segment approaching the stations, allowing a smooth and gradual stop. Although switches at crossovers and turnouts which are located near many stations (particularly terminal stations) generate noticeable sound when a train passes, this alone is unlikely to be a problem, because train speeds are low near stations. These findings were supported by the results of the residential survey. Although more of the respondents rated the effects as "bad" than "good", the majority were indifferent, as shown in Table 5.

TABLE 5

RATINGS OF BART'S SOUND EFFECTS BY STATION AREA RESIDENTS(4)

Stations	Noise Inside Home			Noise Outside Home		
	Percentage of Responses					
	"Good"	"Indifferent"	"Bad"	"Good"	"Indifferent"	"Bad"
Concord	1	71	28	2	57	41
Daly City	6	76	18	6	68	26
El Cerrito	4	86	10	6	80	14

Source: Ref. 21

Train sound is an important adverse environmental impact around some BART elevated lines, however, as shown in Table 6. A majority (51% to 71%) of the respondents at each elevated site except Oakland (where the noise level was high prior to BART) perceived BART train noise to be troublesome. Although some residents in study sites next to BART at-grade lines also cited the train sound as an irritant, the frequency of concern (8% to 18%) was much lower than along elevated lines.

Instantaneous sound levels of BART trains at line locations range from 75 to 85 dB(A), depending on factors such as train speed and track configuration.(5) This is roughly the sound level of a passing delivery truck. To determine the amount of sound actually added by BART to the existing background levels, an averaging function that permits comparisons of intermittent and fluctuating sound sources, the "equivalent sound level", was computed along all aboveground sections of the line.(6) The resulting sound levels were compared with estimated average background sound levels systemwide to identify locations where BART sound is dominant. The relationships between the sound generated by BART and the range of sound in the communities is illustrated in Figure 7. Along approximately 10% (seven miles) of BART's trackways, the daytime time-averaged sound of BART was found to exceed background time-averaged

sound levels by between 5 dB(A) (perceptible) and 12 dB(A) (substantial). This effect diminishes with distance, falling mainly on dwellings that lie within 250 feet (about one block) of the trackways. Because of the lower community sound levels at night, BART's time-averaged sound level may exceed the community's in these same areas by up to 17 dB(A), extending the perceptible effect to about 500 feet.

TABLE 6

RATINGS OF BART'S SOUND EFFECTS BY RESIDENTS NEAR BART LINES

Line Sites	Percentage of Responses: Noise Inside Home			Noise Outside Home		
	"Good"	"Indifferent"	"Bad"	"Good"	"Indifferent"	"Bad"
ELEVATED LINE						
Albany E.	0	50	50	0	45	55
Albany W.	0	29	71	0	33	67
Oakland	4	79	17	6	75	19
Hayward N.	0	49	51	0	55	45
San Leandro	0	59	41	4	45	51
AT-GRADE LINE						
Richmond	1	81	18	2	92	6
Hayward S.	0	92	8	18	76	6

Source: Ref. 21

Orientation of the homes nearest BART lines was found to affect residents' perception of train sound. Residents whose homes faced BART had fewer complaints than those whose backyards abutted the right-of-way. Distance from lines was also a key factor; only the first row of homes along at-grade lines appeared to be significantly affected. Near elevated trackways the frequency of complaints was substantial as far away as two blocks, although much higher in the first block than in the second. Beyond this distance, only small proportions (typically less than 10%) of the surveyed residents reported adverse effects.

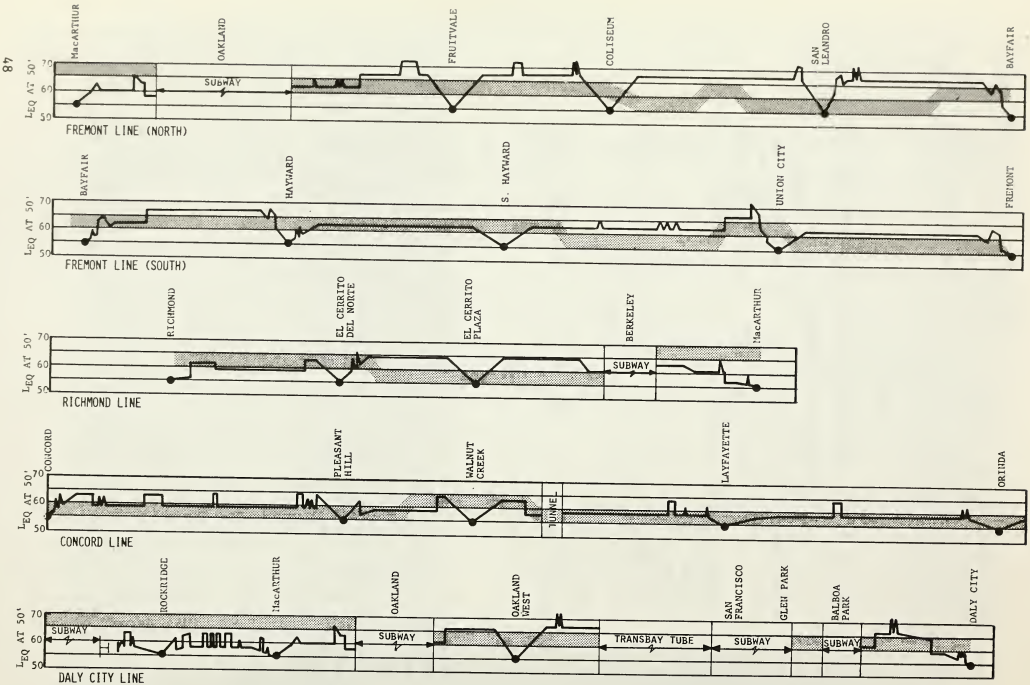


FIGURE 7 **BART AND COMMUNITY NOISE LEVELS**

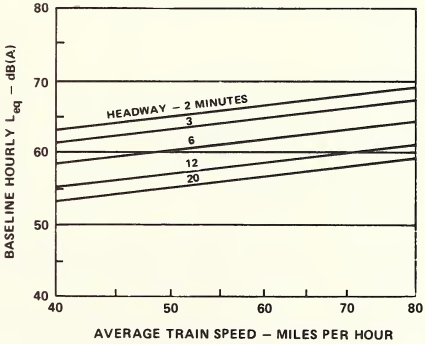
Source: Ref. 15

Factors important to the intensity of BART's train sound include the elevation of the right-of-way, train speed, track and wheel condition, train length and frequency of service, and the presence of switches and curves. The data in Figure 8 indicate how the time-averaged sound levels vary as a function of different train speeds and headways. For instance, a six-car train traveling at 65 mph on tie-and-ballast at six-minute headways would have an average level of 62 dB(A).

FIGURE 8

BART EQUIVALENT SOUND LEVEL (L_{eq}) AS FUNCTION OF TRAIN SPEEDS AND HEADWAYS

L_{eq} shown for a six-car train operating on tie and ballast at-grade or on berm



NOTE: These sound levels include the effects of BART trains traveling in both directions at the headways stated.

SOURCE: Ref. 15

Table 7 lists corrections that can be applied to Figure 7 to account for differences in track configuration and train length. For example, the equivalent sound level for eight-car trains operating at 65 mph with six-minute headways, over a switch on an aerial section, would be 62 + 1 - 5 + 5 = 73 dB(A).

Comparative measurements of the peak sound level of train pass-bys on track segments ground to remove surface roughness showed that track ground at one-year intervals may be more quiet by 3 dB(A) (at 80 mph) to

5 dB(A) (at 40 mph) than track ground at five-year intervals. The average grinding interval for the track from which the system profile was produced was two years.

TABLE 7

CORRECTIONS TO BASELINE EQUIVALENT SOUND LEVEL

CONDITION	dB(A)
Tie and Ballast (berm or grade)	+0
Elevated structure	+5
Switch on berm or grade	+3
Switch on elevated	+5
Curve (radius< 4,500 ft.)	+5
2-car train	-3
4-car train	-1
6-car train	+0
8-car train	+1
10-car train	+2

OTHER ENVIRONMENTAL IMPACTS

VIBRATION AND TELEVISION INTERFERENCE

BART train operations also cause vibration and they interfere with television reception. The vibration level is approximately the same as the intensity of vibrations from a passing delivery truck within a block of the elevated lines. Many residents noted this impact but judged it to be less adverse than train sound. Television interference was noted most often among surveyed residents living adjacent to BART elevated lines. While the effect was widely perceived, it is apparently minor; virtually no one has taken counteracting measures.

EARTH AND WATER SYSTEMS

The components of the natural environment which were studied include soils and geology, drainage and water systems, and living things. Neither the building nor the operation of BART have caused significant damage to them. This is primarily due to the fact that most of BART lies in urban areas and that the few non-urbanized places traversed by BART were not ecologically unique or sensitive. Some minor local effects were found. These include minor land slippage in a BART-related freeway excavation slope in Orinda, and temporary storm water sedimentation due to erosion in trackway embankments in Hayward. No significant ecological systems or components are known to have been disturbed or damaged.

HISTORICAL, CULTURAL, AND OTHER SENSITIVE AREAS

No historical or cultural resources are within the BART right-of-way. Several hospitals, parks, and schools, which constitute sensitive areas, are adjacent to BART. However, at all such locations, BART is next to an existing highway or railroad facility to which the nearby uses were adapted before BART began operations.

UNDERGROUND ELECTROLYSIS

Potential corrosion of nearby underground metallic structures (water pipes, telephone cables) due to stray electricity from the rail distribution system has been identified by BART as a significant problem and is now being corrected. This is a typical problem for electrified rail systems.

BARRIER EFFECTS

BART has caused virtually no change in traffic congestion or safety near its above-ground lines. Because much of the BART line is parallel to other transportation rights-of-way, BART has created few new physical barriers for pedestrians or vehicles. At-grade lines, which are fenced, are used only in semi-rural or already-obstructed locations. Because of extensive use of elevated trackways only twelve of the 300 streets crossed by BART were blocked. Grade separations were built, and parallel traffic improvements were made at forty locations in connection with the construction of BART.

PERSONS AFFECTED BY BART'S ENVIRONMENTAL IMPACTS

The environmental impacts of BART's facilities and operations are confined to an area within a block or two of the stations and lines. The nearest block is by far the most strongly affected. This involves about 13,000 people, less than 1% of the population in the three BART counties.

MAJOR IMPACT DETERMINANTS

The following table illustrates the factors identified by this study which are relevant to the design of new transit systems.

TABLE 8

MAJOR DETERMINANTS OF THE IMPACTS OF FACILITIES AND OPERATIONS

DETERMINANTS: FACILITIES	TYPES AND MAGNITUDES OF IMPACTS
LINE-CONFIGURATION	
Elevated	Sound, vibration, and visual exposure
At-Grade	Barriers to cross-traffic; some sound effects
Subway	None
TRACK ENGINEERING	
Straight runs	Sound levels depending mainly on train speed
Switches, curves, tunnel entrances	Sudden sound changes; intense impacts in small areas.
STATION LOCATION	
Suburban residential	Most sensitive to impacts
Other suburban	Much less sensitive to all types of impacts.

DETERMINANTS: OPERATIONS

Daytime hours	Variety of impacts perceived by nearby residents.
Nighttime hours	Significant increase in sound impacts due to lower ambient noise levels at night.
Speed: 70-80 MPH	Train sound probably above ambient residential levels.
Speed: 30-50 MPH	Train sound probably not above ambient residential levels.
Track/Wheel Maintenance: Typical BART frequency (2-5 Years)	Apparent factor in train sound levels.
Yearly, at a minimum	Reduction of 2-5 dB(A) in train sound.
Train length: 2 cars	Least BART train sound.
10 cars	Significantly higher (about 5 dB(A)) train sound on hourly equivalent basis.

DETERMINANTS:
CHARACTERISTICS OF THE ENVIRONMENT

Adjacent Land Use:	
1-family homes	Most susceptible to all impacts, especially sound.
Multi-family homes	Better adapted to impact but more persons affected.
Undeveloped/open/ recreation	No ecological damage caused by BART; could be serious in different natural settings.
Distance to Nearest Homes:	
Narrow ROW*,adjoining	Potentially significant train sound, vibration, and view obstruction.
Wider ROW (50-100 ft.)	Significantly smaller impacts of all types.
Adjoining Transportation:	
None	Most likely to experience impacts, especially sound.
Low-use railroad, street	Nearly as likely as no adjoining transportation to produce adverse impacts.
Busy railroad, freeway,arterial	Unlikely to produce adverse impacts.

*ROW=Right-of-Way

Source: Ref. 26

These listings constitute the important lessons to be learned from the BART experience about factors which determine the effects of the facilities of a rail rapid transit system. The worst combination of factors along BART lines is the high-speed operation of trains and elevated tracks, combined with narrow rights-of-way and residential areas. The adverse effects of this combination are train noise and vibration, blocked views from the homes nearby, and undesirable shadows on houses and yards. The factor which substantially reduces these impacts along major parts of the BART line is the location of the line along existing freeways, railroads, and arterial streets. The environmental impacts which have resulted from BART are heavily dependent on the specific sensitivities of the surroundings as well as on certain attributes of the system itself. Since other cities and their alternative system routings also differ in sensitivity to impact, the BART experience can be transferred only with a clear understanding of how closely the BART setting and attributes represent those in other situations.

FOOTNOTES TO CHAPTER 3

(1) Wayside Survey, Ref. 21.

(2) Ibid.

(3) Ibid. The figures show the percent of all responses by persons living near each site. Response categories for the questions have been combined in this table. For instance, the category "happy" combines the categories "very happy" and "fairly happy." The number of respondents at each site is shown in Figure 6.

(4) Ibid.

(5) A dB(A) is a measured sound level weighted in a way that gives special emphasis to sound that falls within the range of normal human hearing.

(6) Equivalent sound level is the equivalent steady noise level that contains the same noise energy as would a time-varying noise during the same period.

CHAPTER 4

DIRECT IMPACTS OF THE TRANSPORTATION SERVICE

SUMMARY

BART is carrying a substantial proportion of the kinds of trips it was designed to serve best-- long work-commute trips from outlying areas to the central downtowns. BART's early planners were clear about this objective:

> "...interurban rapid transit must be conceived as providing only arterial or trunk-line connections between the major urban concentrations..."(1)

> "...its primary role is to carry most efficiently the high volumes of passenger traffic which are compressed into the morning and evening rush hours along the main travel arteries connecting residential areas with the employment centers..."(2)

Riders are attracted to BART for several reasons. Among the most important are its travel time advantages over buses for some trips, its out-of-pocket cost advantages over autos, and its service to major destinations where auto parking is difficult and expensive. Such destinations include not only congested downtown San Francisco, but also colleges and universities and major sports and entertainment centers such as the Oakland Coliseum.

BART primarily attracts trips with destinations quite close to stations, and will probably continue to do so. People in the BART service area make many trips to scattered destinations outside central areas for social, recreational, and personal business reasons. It is unlikely that BART will ever carry a large proportion of these trips, and this was never intended to be one of its main purposes.

BART has increased the trip-making capacity of the two most congested corridors it was designed to influence, the Bay Bridge and Caldecott Tunnel corridors. Since the introduction of BART, transit trips have increased in those corridors at a much faster rate than auto trips, and BART has absorbed most of the increase in travel during peak periods. However, overall traffic volumes have not been reduced from their levels prior to BART service. The immediate effect of the introduction of BART in both corridors was a reduction in weekday highway traffic flow by the equivalent of about two years' traffic growth, but the trips diverted to BART were replaced by other trips. These "new" trips may be due to local population growth, to changes in economic activities, or to trips that were diverted from other routes when BART relieved traffic congestion on the bridge. Some of the new trips may be trips which had previously been suppressed because of the congested travel conditions.

Overall, BART's riders reflect the characteristics of the population in the service area, with two exceptions. There are much higher proportions of young persons and of college-educated persons on BART than in the population at large.

There are three types of limitations on current BART ridership and impacts: (a) limitations due to BART's design; (b) limitations due to the

unreliability of BART service; and (c) limitations on access to BART by bus and auto.

The basic BART design, a regional rail line to serve long trips from outlying areas to the downtowns, does not and was not intended to serve all types of trips and travelers in the area. It was meant to be the trunk-line portion of the regional transportation system. Other elements of the transportation system were expected to serve the majority of transit trips within cities.

BART's unreliability has deterred some persons from using the system. The service reliability is slowly being improved, and this improvement, in addition to the introduction of new and expanded services, can be expected to result in increased ridership.

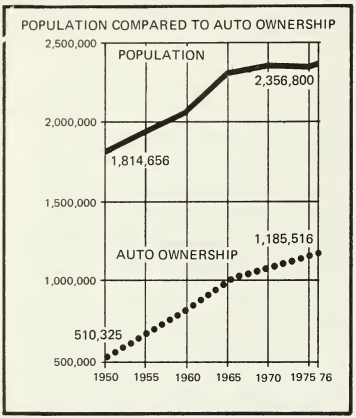
Access to stations is likely to remain a constraint on BART's ridership for a number of years. BART's stations in San Francisco and in the urbanized area of the East Bay from Richmond to Hayward are reasonably well served by local transit. However, feeder bus service to suburban stations is sparse and infrequent. Frequent and dense bus service can rarely be operated economically in low density suburbs.

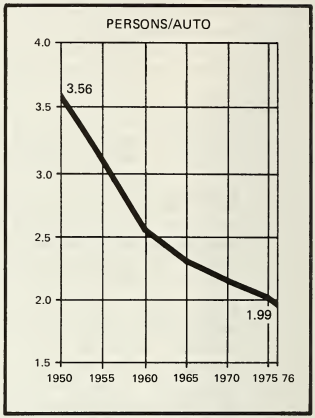
A 1978 BART survey of its all-day parking spaces found that twelve of twenty-three station parking lots were filled to capacity. Overall, the lots were about 90% full. Parking is being expanded in some areas, and alternatives for improving access are being studied by the BART staff.

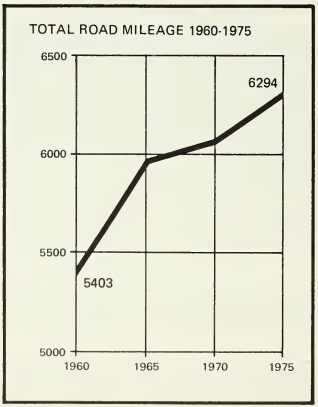
As traffic congestion in the two major corridors BART serves increases more motorists may be expected to switch to BART. This will depend, however, not only on improvements in BART's service, but on the relative costs and incentives for using the automobile. If changes in urban development patterns, i.e., the pattern of desired trip origins and destinations, occur in the future, they are likely to produce substantial effects on the use of the rail system. Even then, while BART may become a more significant factor in its intended long-trip, downtown-suburban market, it can only be a relatively small increment in total regional transportation service. The charts in Figure 9 show the context for BART's impacts: auto ownership has been increasing faster than the population, total road mileage continues to be expanded, and the number of persons per auto continues to decline.

FIGURE 9

TRENDS IN THE BART DISTRICT: CONTINUED RELIANCE ON AUTOMOBILES







Source: California Statistical Abstract, 1976, 1977

LEVEL AND PATTERN OF BART'S RIDERSHIP(3)

BART carried about 146,000 one-way trips each week-day in late 1978, and patronage is forecast to be about 180,000 trips each week-day by 1980. In 1962 BART's patronage was forecast to be 259,000 one-way trips at full service levels. However, the system is not providing the level of service on which the forecast was based. Trains currently operate every six minutes through the Transbay Tube, rather than every 90 seconds as anticipated in 1962. They are expected to operate every 4 1/2 minutes during peak periods transbay, in San Francisco, and elsewhere where routes merge when the Richmond transbay line is added. Maximum train frequencies of 2 1/2 minutes are expected in the future. Patronage forecasts have been revised downward to reflect this level of operations.

TRENDS IN PATRONAGE

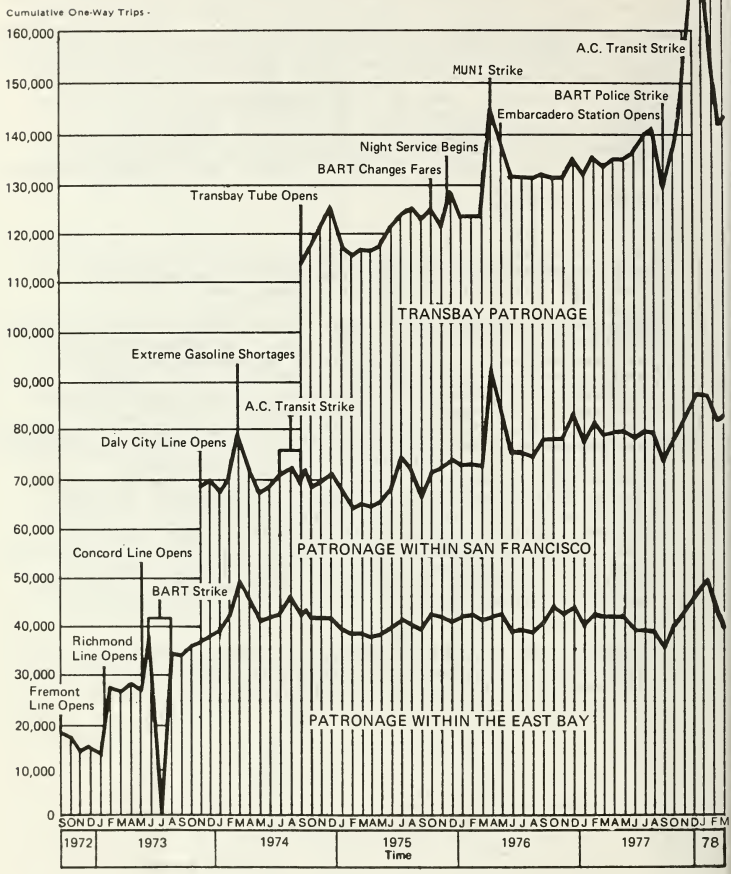
Figure 10 shows cumulative BART patronage trends by the three principal components: (a) trips within the East Bay; (b) those within San Francisco; and (c) those through the Transbay Tube.

Patronage has responded fairly quickly to the opening of each new section of the system; to operational changes such as the addition of night service, adoption of a new fare schedule, and addition of a new downtown station; and to external events such as strikes by other transit operators. The lack of growth in ridership in the East Bay since late 1974 reflects the competitiveness of existing AC Transit local and inter-city express bus service, the lack of a direct transbay route from the Richmond line, and the absence of major daytime, weekday service improvements. West Bay patronage, by contrast, has increased substantially in the past two years. The increase can be attributed to several factors. First, many MUNI patrons became familiar with BART during the 1976 MUNI strike and stayed with BART after the strike was settled. Second, the opening of the Embarcadero Station lessened the crush load at the Montgomery Station and attracted riders who work in the new highrise buildings near the foot of Market Street. Third, the provision of additional parking spaces and the expansion of feeder bus service to the Daly City Station in 1976/77 improved access to that heavily-used station.

Transbay travel has shown a fairly steady upward trend which has resulted, for the most part, from the opening of Embarcadero Station in San Francisco and general growth in the transbay travel market.

FIGURE 10

CUMULATIVE AVERAGE DAILY PATRONAGE EACH MONTH



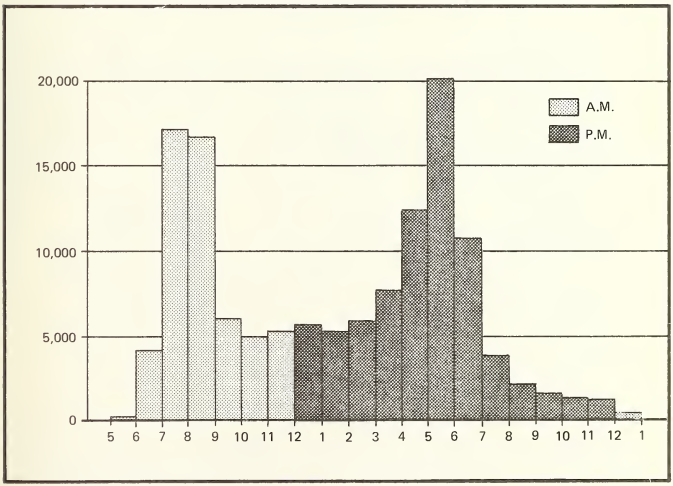
Source: BART Patronage Reports

CHARACTERISTICS OF BART TRIPS

BART travelers' principal destinations are the four downtown San Francisco stations, which account for one-third of the total number of station exits on the system all day, and two-thirds during the morning peak. Figure 11 shows the number of patrons entering all stations each hour of a typical day, and illustrates the marked peaking of BART's ridership and its much smaller midday plateau. Unlike Washington, D.C.'s Metro, BART does not serve crosstown trips, and therefore serves few short, midday trips for lunch or shopping. The broad and tall afternoon peak reflects the varied nature of afternoon trips. While nearly 90% of the morning peak trips are for work, the afternoon peak includes many homebound shoppers and students.

FIGURE 11

PATRONS ENTERING STATIONS BY TIME OF DAY (MAY 1977)



Source: 1976 Passenger Profile Survey

DISTRIBUTION BY TIME, GEOGRAPHY, PURPOSE: Approximately 50% of BART's patronage is carried in the four peak hours of travel (7:00-9:00 a.m. and 4:30-6:30 p.m.). About 10-12% of all trips are in the evening hours (6:30 p.m.-midnight). The proportion of BART's patronage in each of its major markets has remained relatively stable for the last two years: 41%-44% transbay, 28%-34% East Bay, and 25%-29% West Bay. (Week-end service was not provided on a regular basis when this assessment was made.) (4)

As its planners intended, a majority of BART trips are to or from work, as shown in Table 9.

TABLE 9

PERCENT* OF TRAVELERS BY TRIP PURPOSE (May, 1976)

	Purpose				
	Work	Business	School	Personal Business	Other
Morning Peak 6 - 9 AM	87.0	0.2	8.9	1.3	2.6
Midday Off-Peak 9 AM - 3 PM	27.8	6.6	15.6	22.3	27.7
East Bay 6 AM - 3 PM	54.3	1.3	20.6	11.0	12.8
West Bay 6 AM - 3 PM	63.7	3.2	8.6	10.8	13.7
Transbay 6 AM - 3 PM	58.1	5.0	7.4	12.2	17.3
Total 6 AM - 3 PM	58.8	3.3	12.1	11.1	14.7
Total (est.)(5) 6 AM-Midnight	66.8	2.4	11.2	8.5	11.1

*Total within each row is 100.
Source: 1976 BART Passenger Profile Survey

Trips to and from school account for the largest single category of non-work trips on BART. The substantial proportion of school trips in the East Bay is due to convenient access from BART to the University of California at Berkeley, the California State University at Hayward, and several two-year community colleges.

The average length of trips on BART is nearly thirteen miles; trips from the Concord line to downtown San Francisco average over twenty-two miles. This average is much higher than for other, more compact rail transit systems like the New York City MTA (six miles), or the Chicago CTA (seven miles). It is also longer than the average work trip (8.5 miles) for all workers in the five-county San Francisco-Oakland Standard Metropolitan Statistical Area (SMSA). (6)

GETTING TO AND FROM BART: Most BART patrons (72%) travel less than fifteen minutes to reach a BART station from their homes, and 82% travel less than fifteen minutes from BART to reach their final destinations. People traveling by bus to a BART station make the longest access trips, on the average. Over three-quarters of those who take a bus to BART travel over ten minutes to the station, and more than half travel more than fifteen minutes. The longer bus access travel times reflect the fact that local buses make frequent, time-consuming stops.

The dominant mode of access from home to BART is the auto, but this varies by time of day, location, parking availability, local bus service, residential density, and trip purpose. Almost half of all BART riders drive to a station and walk from the station to their destination.

TABLE 10

PERCENT* OF TRAVELERS BY TRAVEL MODE TO AND FROM BART

(Home-based trips only, 6 AM - 3 PM; May 1976)

MODE	FROM HOME TO BART	FROM BART TO DESTINATION
Auto	56.7	3.9
Drive Alone	33.1	1.1
Shared Ride	6.5	0.7
Drop-off/Pick-up	17.1	2.1
Bus	19.8	18.0
Walk	22.0	77.5
Other (including bicycle & motorcycle)	1.5	0.6

*Total within each column is 100.

Source: 1976 Passenger Profile Survey

The patterns of travel to and from BART suggest that the system is most convenient when the trip to BART is fast (auto is faster than bus or foot for most travelers), and when the portion of the trip from BART to the destination is direct (walking requires no waiting or transfers).

SOURCES OF BART'S RIDERSHIP

One of the most important concerns of transportation planners is the source of ridership. This means two things -- the geographic origins of riders and their prior mode of travel.

The geographic distribution of BART ridership is shown on the map on the following page (Figure 12). The shaded areas represent the primary BART service area, which accounts for 80% of the origins of BART's average daily ridersip. They include about 1.5 million persons, 61.2% of the total population of the BART District counties, plus 96,600 persons in northern San Mateo County. The geographic distribution is shown in Table 11.

TABLE 11

GEOGRAPHIC DISTRIBUTION OF BART RIDERS' ORIGINS*

(May 1976)

County	Percent of BART Rider Origins	
San Francisco	21.3	
Alameda	37.4	
Contra Costa	26.7	
Subtotal - BART District		85.4
Northern San Mateo**	10.3	
Santa Clara	1.9	
All Other Areas	2.4	
Subtotal - Outside BART District		14.6
TOTAL		100.0

* Travelers making the first leg of a round trip.

** Includes the cities of South San Francisco, San Bruno, Brisbane, Colma, Daly City, Pacifica and Millbrae.

Source: 1976 BART Passenger Profile Survey

The second meaning of the source of ridership refers to BART's "mode diversion," its ability to compete effectively with other transportation modes and attract travelers from them. The 1962 "Composite Report" predicted that 61% of BART's patrons would be diverted from automobiles. As shown in Figure 13, 55.1% of those who had made the trip before by another means reported that they had done so by auto (37.1% driving alone, 18% sharing a ride). This approaches the predicted 61%.

PRIMARY BART SERVICE AREA

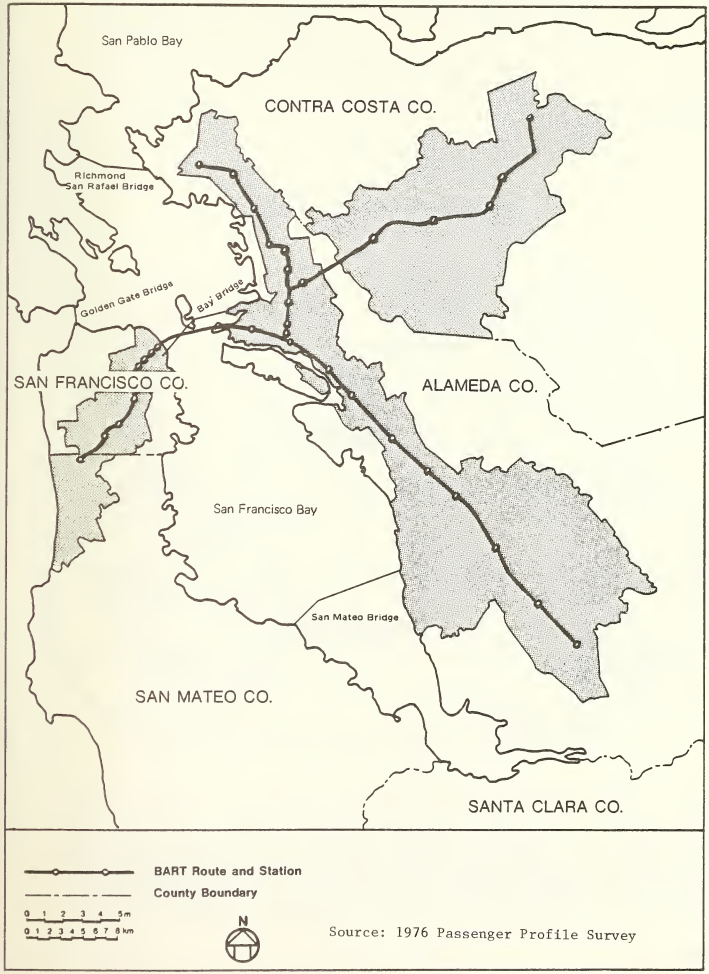
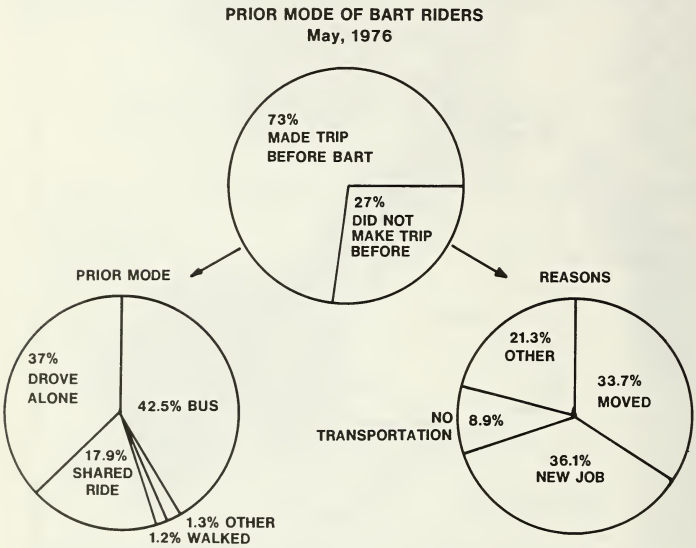


FIGURE 12

The survey of BART patrons found that only 73% of riders had made the same trip before using BART. Most of the 27% of "new" trips were to work (59.6%) or to school (15.8%). In general the persons making these trips had recently moved, changed jobs, or become students. A small percentage said they did not have convenient transportation available before BART service began (8.9%). Only half the people in this category were making work or school trips, suggesting that the lack of public transit is more likely to cause discretionary trips to be suppressed than those which must be made regularly.

FIGURE 13



Source: 1976 Passenger Profile Survey

It is difficult to judge the number of trips on BART which were "induced" by BART - that is, trips which would not otherwise have been made without BART. Nearly 96% of all those making "new" trips said they would make the trip even if BART were not operating. Eighty-five percent said that

an auto was available to them to make the trip. The "no previous means of transportation" responses (8.9% of new trips or 2.4% of all BART trips) probably represent the maximum number of trips on BART which can be considered to be induced.

DETERMINANTS OF BART'S RIDERSHIP

The reasons travelers choose to use BART or a bus or automobile have been assessed in two ways. First, objective measurements of the time and costs of various trips in the BART service area were made. Second, perceptions of the relative advantages and disadvantages of BART, buses and automobiles were assessed by surveying people using these modes.

TRAVEL TIME COMPARISONS

As originally intended, BART's most significant effect on travel times has been a reduction in the time required to travel between the more distant East Bay suburbs and downtown San Francisco and Oakland by public transportation. Transit travel time improvements for short-distance trips and for travel to non-downtown destinations have been small, particularly in areas where local transit provided a high level of service prior to BART. Travel times have improved more for travel from BART's Concord and Fremont lines than from the Richmond line, reflecting the necessity to transfer for transbay trips from the Richmond line. The planned addition of an additional transbay line will improve transbay travel times from areas served by the Richmond line.

BART's aggregate effects on travel times in the greater service area (San Francisco, Alameda, Contra Costa and Northern San Mateo Counties where 96% of BART trips originate) were analyzed by calculating the time required to make hypothetical trips in three different ways:

(a) Using the with-BART public transportation system -- a computerized approximation of the transit network, including BART, that actually existed in 1976. (7)

(b) Using a hypothetical no-BART public transportation system -- an approximation of the transit network that might have existed in 1976 if BART had not been built. (The No-BART Alternative [NBA] is described in Chapter 1 and Appendix B.) (8)

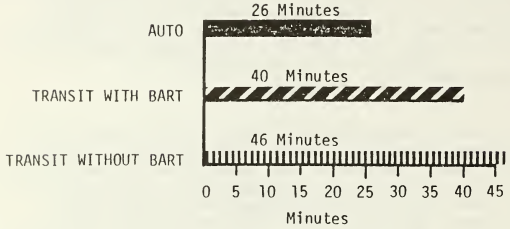
(c) Using hypothetical travel by automobile over a computerized network of highways and roads that approximated those that actually existed in 1976. (9)

TRAVEL TIMES FOR THE "WITH-BART" VS. THE "NO-BART" SYSTEM: The comparisons shown in Figure 14 indicate that travel times with BART are an improvement over the hypothetical no-BART transit system for trips from origins throughout the greater service area to: (a) fifty major employment centers in the peak period; (b) to downtown San Francisco in the peak period; and (c) to fifty major shopping and service areas in off-peak periods.

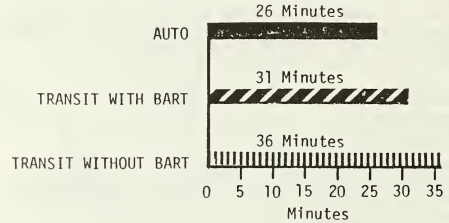
FIGURE 14

NETWORK TRAVEL TIME ACCESSIBILITY COMPARISONS

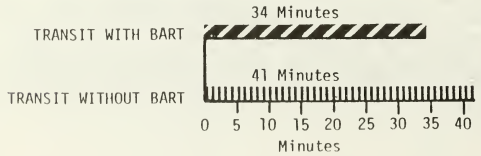
1. AVERAGE PEAK PERIOD TRAVEL TIMES IN THE GREATER SERVICE AREA TO THE MAJOR 50 EMPLOYMENT CENTERS



2. AVERAGE PEAK PERIOD TRAVEL TIMES IN THE GREATER SERVICE AREA TO DOWNTOWN SAN FRANCISCO



3. AVERAGE OFF-PEAK TRAVEL TIMES IN THE GREATER SERVICE AREA TO THE TOP 50 SHOPPING AND SERVICE AREAS



Comparisons of the with-BART and no-BART times for trips between different areas within the greater service area (which are not shown in Figure 14) indicate that BART provides the greatest improvements in transit travel times from outlying suburban areas, where little transit service was available before BART, to the central areas of San Francisco, Oakland and Berkeley. The off-peak improvement with BART is greater than the improvement in the peak period. This reflects BART's continuous 12-minute service on each route during the day, while most bus services in the NBA were curtailed in the midday off-peak period.

TRAVEL TIMES FOR THE WITH-BART TRANSIT SYSTEM VS. AUTOS: These calculations are shown in Figure 14, comparisons 1 and 2. Travel times by automobile are generally shorter than by public transportation. The with-BART transit system is most competitive with autos for trips to downtown San Francisco (comparison 2), where traffic congestion is not uncommon.

COST COMPARISONS

Out-of-pocket costs for automobile, bus and BART trips depend on fares, tolls, parking charges and gasoline prices. The costs described here are examples of the costs of selected trips in 1976. Since that time bus fares for trips in the East Bay and between the East Bay And San Francisco have been increased. Fares for short trips on buses and on BART are now generally equal, and bus fares for longer trips are the same or somewhat lower than BART fares. Gasoline prices and bridge tolls have also been increased. BART fares in mid-1979 remained unchanged from their 1976 levels.

In 1976, on the basis of fares alone, BART was more costly than buses for most trips. For example, the fare from the East Bay to downtown San Francisco was $0.75 to $1.25 on BART, depending on the distance traveled. For patrons who drove or took a bus to a BART station, the total trip cost was increased by the out-of-pocket expenses of the access trip. The AC Transit bus fare for a similar trip was between $0.60 to $0.85.

BART fares were lower than out-of-pocket costs for automobile travel, particularly for transbay trips to downtown San Francisco where a motorist paid $0.60-$0.75 for the bridge toll plus parking charges which averaged$1.25 a day for commuter parking. The total cost of a 20-mile transbay auto trip was about $5.25-$5.40, assuming $0.17 per mile for operating the automobile.

TRAVELERS' PERCEPTIONS

Travelers' ratings of the relative advantages of travel by BART, buses and automobiles were investigated in surveys made in 1974, 1975 and 1977. (10) Although the surveys were dissimilar in scope and method, there is a fairly consistent over-all pattern of responses. Travelers generally agreed that the important determinants of choice are total door-to-door travel time and factors related to travel time, such as waiting time and the dependability of arriving at their destinations on time. BART was not

given high ratings on these factors, in general. Travelers generally perceive BART favorably with regard to its "qualitative" aspects; comfort, safety from accident, and security from crime.

The factors reported by travelers as the important determinants of choice vary significantly among individuals as a function of their choice of mode and the circumstances of their travel needs.

Persons choosing BART over an automobile rate the lower cost of a BART trip, the opportunity to avoid driving in congested traffic, and the difficulty and expense of parking in downtown districts as important factors in their decisions. These travelers generally accept that BART takes longer and is less reliable than a car, but they consider these disadvantages to be outweighed by the advantages they perceive.

Persons choosing an auto over BART stress the advantages of flexibility; an automobile allows them to travel at the preferred time and to combine several purposes in one trip. Some commuters mentioned their need to have an automobile available at work as an important factor in their choice.

Travelers' decisions to take BART rather than a bus are generally based on the travel time savings offered by BART. Respondents to the 1974 survey of transbay travelers who chose BART over a bus also rated the comfort of a ride on BART as a major factor in their choice. This probably reflects the fact that many BART riders are on board for fairly long trips and therefore the comfort of the ride is perceived as an important factor by some travelers.

Among people choosing a bus over BART, the lower cost and greater dependability of the bus are rated as important factors. (Changes in transit fares and improvements to make BART service more reliable may change these perceptions in the future.) Total travel time and the inconvenience of BART trips are also rated as important factors. "Inconvenience" is frequently used by respondents to mean the time and trouble involved in transferring between vehicles, whether BART or a bus. The fact that travel time is rated as an important element in the decisions of travelers choosing a bus over BART as well as those choosing BART over a bus reflects the fact that BART is faster for some trips where bus routes are circuitous, and a bus trip is faster for some trips which begin and/or end at some distance from a BART station.

Travelers' ratings of the importance of various factors and of their satisfaction with their travel mode are shown in Table 12. Factors associated with BART service are given similar ratings by persons choosing BART over automobiles and by persons choosing BART over buses. Both groups gave relatively high ratings to security from crime on BART, to the opportunity to engage in activities such as reading or working while traveling, and to the walking time associated with a BART trip. "Walking time" generally refers to the fact that BART brings many travelers closer to their workplace destinations in San Francisco than would a bus trip from the East Bay, which terminates south of Market Street, or an auto parked in a lot on the edge of the business district.

TABLE 12

IMPORTANCE OF FACTORS IN MODE CHOICES
(1977 Work Travel Survey)*

IMPORTANCE RATINGS **

Attribute	Travelers: BART over Auto	Travelers: Auto over BART	Choosing: BART over Bus	Choosing: Bus over BART
Door-to-Door Cost	100	63	21	100
Door-to-Door Time	12	92	100	44
Wait, Transfer time	2	51	49	40
Convenience	12	100	59	67
Dependability	4	73	26	67
Crowding	--	19	17	26
Comfort	3	3	18	5
Safety, Security	7	17	23	4
Flexibility	1	22	6	1

SATISFACTION WITH ALTERNATIVE MODE ATTRIBUTES
(1977 Work Travel Survey)

AVERAGE SATISFACTION RATINGS ***

Attribute	Travelers: BART over Auto BART trip	Travelers: Auto Over BART Auto Trip	Choosing: BART over Bus BART trip	Choosing: Bus over BART Bus trip
Door-to-Door Cost	4.6	5.3	4.5	5.9
Door-to-Door Time	4.4	6.1	4.6	5.3
Walking Time	6.0	6.5	5.8	6.0
Dependability	4.0	6.3	4.3	5.5
Seat Availability	4.8	n.a.	4.7	5.7
Security from Crime	5.5	5.8	5.4	5.1
Ability to do what one wants while traveling	5.4	5.8	5.3	5.4
Flexibility	4.6	6.6	4.6	4.7

* Source: Ref. 38. Number of respondents = 8,400

** Survey respondents listed the important factors in their choice in their own words. Responses were grouped and the ratings determined by summarizing the number of times each factor was mentioned as the first through fourth most important factor: they were then normalized so the most frequently mentioned equals 100.

*** Average ratings from a seven point scale: 7=very satisfied.

The ratings indicate that auto users are more satisfied with their travel mode than persons who use public transportation, on the average, and that bus patrons are generally more satisfied than BART patrons. Two of the factors on which BART ratings are relatively low--dependability and seat availability-- can be expected to be perceived more favorably as BART service is improved. Satisfaction with the flexibility of travel by both bus and BART is rated relatively low: public transportation can seldom equal the flexibility of a private vehicle.

Travel time is given lower ratings by BART patrons than by patrons of autos and buses. Travel time for the long-haul portion of BART trips is likely to improve somewhat when BART service is up-graded, and when better coordination of bus and BART service is achieved. However, unless pronounced land use changes occur in the Bay Area, a trip on BART will continue to involve a relatively long journey to and/or from the station for many residents of the area. Satisfaction with the cost of a BART trip is also rated relatively low. However, BART riders who switched from autos indicated that they are more satisfied with the BART costs than the costs of their previous auto trips. These ratings of alternative mode choices are not shown in Table 12. They are fully described in Reference 38.

BART RIDERS: WHO IS SERVED?(11)

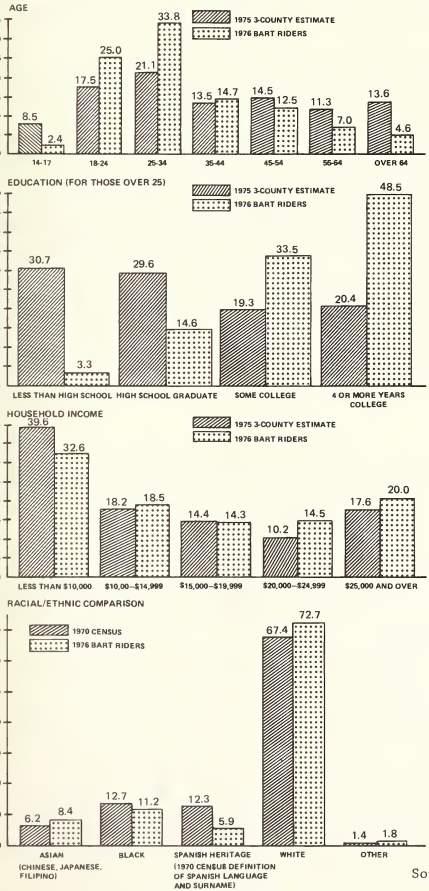
The characteristics of BART riders are of most interest to those concerned with questions of social equity: is BART used by the population at large, or only by certain groups?

As the charts in Figure 15 illustrate, BART riders are similar to the population of the three-county District in terms of racial, ethnic, sex and income characteristics. (12) They are unlike the general population in terms of age and education. BART riders tend to be younger than the general population as a result of the large proportion of work and school trips made on the system and the relatively minor use of BART by elderly persons.

Differences between the education of BART riders and the population in general are striking. A very small proportion of BART riders are not high school graduates (3.3%), while 48.5% have a college education or better. This reflects BART's use by college students and by suburbanites traveling to office jobs in the central cities.

FIGURE 15

CHARACTERISTICS OF BART RIDERS AND THE 3-COUNTY POPULATION *



Source: 1976 Passenger Profile Survey

* The age, education and income data are from the 1970 Census adjusted to 1975, based on national trends in these characteristics. There is no basis, however, for adjusting 1970 racial/ethnic census data.

BART'S SHARE OF TRAVEL

BART planning was focused on increasing travel capacities at the most heavily used urban gateways in the region. Travel at two of these gateways, the San Francisco-Oakland Bay Bridge and the Caldecott Tunnel is analyzed here.

The two-level Bay Bridge between Oakland and San Francisco provides five lanes for one-way traffic on each deck. AC Transit buses carry the majority of bus traffic on the bridge. A bus priority lane through the toll plaza was designated in 1970; in late 1971 a similar carpool priority lane was provided, and in 1975 carpools were made toll-free. A recent major change was the installation of a lane-metering system beyond the toll booths for westbound traffic in 1974. The system permits traffic in the seventeen toll lanes on the westbound approach to the bridge to merge smoothly into the five lanes on the bridge during peak periods. Under this arrangement the capacity of the bridge is maintained at about 8,700 vehicles per hour during the peak period. The bridge regularly carries from 90,000 to 100,000 vehicles per week day in each direction. Transbay BART service through the underwater tube paralleling the bridge was begun in September 1974. In 1977 BART carried 19.6% of all weekday person trips between 6:30 a.m. and 6:30 p.m. in the westbound direction in the Bay Bridge corridor, and 27% of the morning peak period trips, as shown in Figure 16. Since the introduction of BART service transit travel has increased by 38% during the peak morning travel period, and 155% during the off-peak period, as shown in Table 13. The increase in trips by automobile was much less in both time periods. (13)

TABLE 13

CHANGES IN TRAVEL PATTERNS IN THE BAY BRIDGE AND CALDECOTT CORRIDORS

1973-1977
(Westbound person-trips)

	Increase In Trips By Auto		Increase In Trips By Transit	
	No.	Percent	No.	Percent
BAY BRIDGE CORRIDOR				
AM Peak(6:30-9:00)	1,500	6	8,200	38
Off-Peak(9am-4pm)	5,400	13	7,000	155
CALDECOTT CORRIDOR				
AM Peak(6:30-9:00)	1,300	1	3,500	50
Off-Peak(9am-4pm)	-0-	0	1,700	100

Source: Ref. 33

The Caldecott Tunnel is actually a set of three two-lane tunnels which carry State Route 24 through the Berkeley Hills, linking the older, urbanized area of the East Bay along the Bay shore to the newer, suburban

development in central and eastern Contra Costa County. During the peak periods, the central tunnel is reserved for the peak direction, so that four lanes operate in the peak direction (westbound in the morning, eastbound in the afternoon). BART service began through the Berkeley Hills between Oakland and Concord in May 1973, but attracted a substantial proportion of travelers only after transbay service began in September, 1974. Since then, BART's Concord-Daly City route has been its most successful, and all parking lots are now filled to capacity at the five suburban Contra Costa County stations. BART has been able to assign two or three additional trains to that route during the peak to lessen the crowded conditions and meet the demand.

Before BART, the only transit service provided to central Contra Costa County was the commuter bus service offered by Greyhound Lines. In 1973, a peak traffic year, Greyhound ran 144 buses through the Caldecott Tunnel in the morning peak period. At present, fewer than thirty buses operate during the peak. With the introduction of BART, Greyhound received permission from the Public Utilities Commission to phase out its competitive service, but only to the extent that demand shifted to BART.

BART carried 21.3% of the 6:30 a.m. to 6:30 p.m. trips in the Caldecott corridor in 1977, and 31% of the morning peak period trips. The increase in transit travel in the corridor since BART's transbay service began has been substantial, as shown in Table 13. There has been virtually no increase in the number of trips by automobile. Congestion during the peak periods of travel and the relatively frequent BART service during off-peak periods have contributed to the growth in transit travel in both corridors.

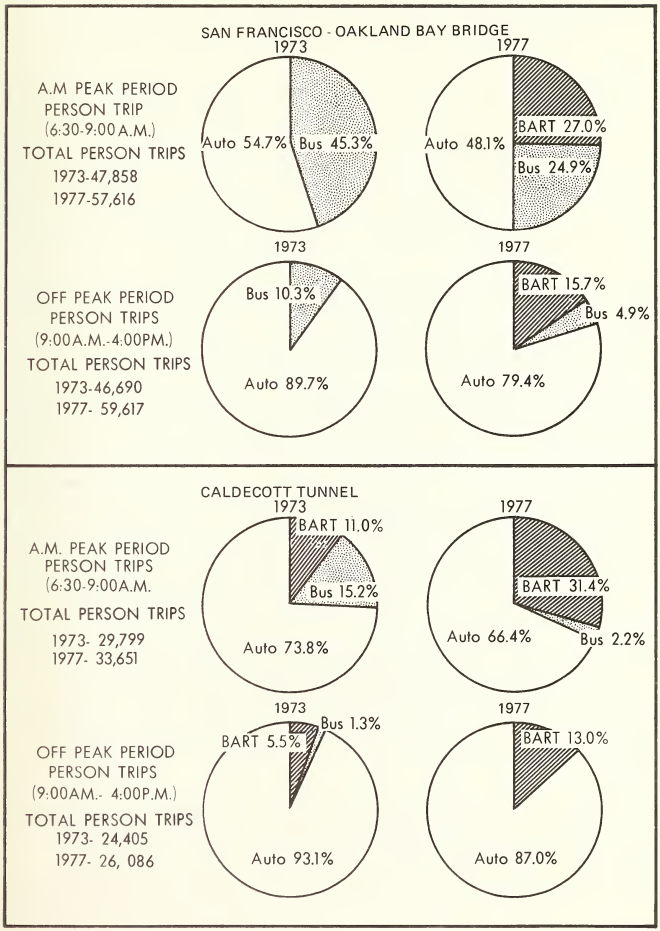
Although BART carries a significant proportion of the trips in the corridors it serves, its share of all trips made in vehicles within its greater service area is small. BART carries about 2% of all the trips and about 5% of all work trips in the greater service area. However, BART's share of trips to and from work in its primary service area is much higher (18%), and for transbay work trips within the primary service area, it is higher still (32%). Fifty-three percent of the work trips from the Concord corridor to the central San Francisco business district are made on BART. This reflects the fact that BART service provides the greatest advantages for relatively long trips between outlying suburban areas and the central business districts of the major cities.

The share of trips which could reasonably be made on the BART system was investigated in two surveys. The 1975 Regional Telephone Survey (Ref. 38) asked residents of the area to describe all their trips on a given day, and to indicate which of those could have been made by BART. Respondents reported that 11.2% of all of their trips could reasonably be made by BART, and their responses indicated that BART carried about 21.3% of its total market defined in that way. Similarly, in the 1977 Work Travel Survey of those who work in the areas served by BART, 33% of all the respondents, and 40% of those living in the primary service area, reported that their work trips could be made using BART. Actual BART use indicates that it has captured about 40% of this potential work trip market.

In terms of total travel in the region, BART's 2% of all trips may seem to be a very small proportion, and a potential target of 11% not that much more. However, as a 71-mile system in an area of 330 square miles, BART cannot be expected to carry a major portion of all the trips made in the area. BART's original patronage projection for full service was only 259,000 trips per day. Were BART carrying that many passengers now, it would account for only 5% of all weekday trips. Moreover, work trips--BART's principal market at the present time--account for only 30% of all trips in the greater BART service area.

FIGURE 16

CHANGES IN AUTO/TRANSIT SHARES IN WESTBOUND PERSON-TRIPS, 1973-1977



Source: Ref. 28

BART was designed to be attractive and comfortable in order to attract motorists from their cars, thereby forestalling crippling traffic congestion in the major corridors leading to the central cities. It was expected to absorb a significant share of the growth of travel in these corridors, and to enable them to accommodate an increasing travel demand. A time-series of data on travel in two major corridors leading to San Francisco and Oakland, the Bay Bridge and the Caldecott Tunnel corridors, has been examined to determine the system's effects on traffic.

THE BAY BRIDGE CORRIDOR: In the two years after September, 1974, when transbay service began BART carried an average of about 27,000 persons per day in each direction in the Bay Bridge corridor. BART had the immediate effect of reducing bridge traffic flow in 1974 by roughly 3,000 vehicles per day in each direction. This reduction represented about two years' historical growth in Bay Bridge traffic, but is also of the same order as normal week-to-week variations in traffic flow. Two years after transbay service began, automobile flow on the bridge had returned to the level which might have been anticipated without the introduction of BART. The projection was based upon an extrapolation of long-term and seasonal trends, coupled with statistical control for the major external event affecting traffic--the large increase in gasoline prices.

Of the 53,000 transbay BART trips made daily in the first two years (both directions), an estimated 40%, or 21,000 trips, would have been made by automobile if BART had not been available. Assuming an average auto occupancy of 1.4 persons per vehicle, this suggests that BART removed about 7,000 vehicles per day from the Bay Bridge in each direction.(14) The sum of the reductions in Bay Bridge traffic, estimated to be a result of both gasoline price increases and BART's introduction, is in excess of 9,000 vehicles per day in each direction. However, as noted, the observed reduction in traffic amounted to only 3,000 trips per day. It is believed that the 6,000 "new" trips were caused by travelers reacting to the lessened congestion on the bridge by making trips that were previously suppressed or trips which had previously been diverted from other destinations or routes. This new traffic appears to have nearly completely offset BART's contribution to reducing traffic volumes.

Another way to look at the effect of BART on the Bay Bridge is to examine trends in trip making before and after the start of BART service. A statistical analysis indicated that the pattern of growth in transbay trips was closely related to the number of jobs in employment categories such as trade, finance, and services, which are predominantly located in central business districts. The analysis showed that vehicle volume growth was relatively constant year to year from 1965 to 1977, with an interruption in the trend in 1974. The interruption may have been due to a combination of the opening of the transbay BART line, the temporary fuel shortage, and the permanent rise in fuel prices. However, the impact of the fuel situation on vehicle volumes was not supported statistically in the long-term analysis. As shown in Figure 17, there is a general tendency for the post-BART trend line at the Bay Bridge to begin at a level below that at which the pre-BART line ended, and then to climb at a

faster rate, particularly during the off-peak. As peak-period volumes approached bridge capacities, the growth rate slowed. The trend lines indicate that the opening of BART, with a possible assist from the fuel crisis, temporarily reduced vehicle volumes, but that these are now catching up. It will be several more years before there will be enough data points to judge whether growth will return to the old rate.

The transbay mass transit passenger trends behaved in a somewhat similar fashion until 1973, generally growing each year. This is especially true for the trends in peak period commuting patterns. In the pre-BART/post-BART analysis, the post-BART trend line starts at a higher level than that at which the pre-BART line ended, suggesting a one-time jump in transit riding induced by BART. The slope of the post-BART trend line is steeper than that of the pre-BART line, suggesting that transit patronage experienced a more permanent gain in 1974 and that the trends will not converge to an extrapolation of pre-BART trends. Of special interest is the large jump in transit riding in the midday off-peak period, noted in a previous section.

Because of the small net reduction in traffic volumes (BART's reduction offset by "new" trips), there has been little impact on highway travel times and traffic congestion. The only noticeable and statistically significant change in peak period vehicular traffic patterns is a reduction in flow rates in the early part of the morning peak period. This occurred because a lessening of congestion in the middle of the peak allowed commuters to begin their trips a little later in the morning. The average total vehicle flow between 6:00 and 6:30 a.m. dropped 29% (840 vehicles) after the BART opening; the following half hour dropped 7% (300 vehicles).

THE CALDECOTT TUNNEL CORRIDOR: The trend lines in all-day and peak-period traffic through the tunnel are similar to those for the Bay Bridge. The post-BART trend line starts out considerably below the level at which the pre-BART line left off. At the tunnel, the rate of growth decreased somewhat after 1974. The "catching up" seen on the Bay Bridge is not yet evident. While there was an abrupt shift in modal split, little effect was seen on the overall rate of traffic growth.

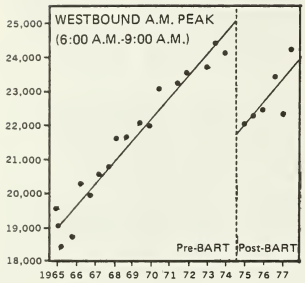
BART has contributed to a general increase in the number of trips made in the two corridors, and in the number and proportion of transit trips. BART has also increased the ability of people to travel where and when they want. Long-term net reductions in highway traffic have not occurred, although transit travel has increased markedly. The BART experience confirms experiences elsewhere: the addition of new facilities for travel in corridors with a high travel demand will result in additional trips until the facilities are once again congested.

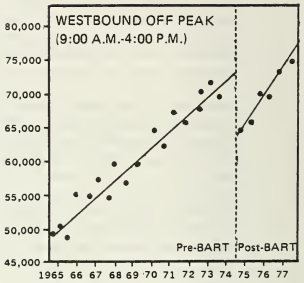
FIGURE 17

TRENDS IN TRAVEL ACROSS THE BAY BRIDGE*

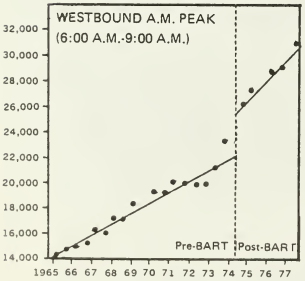
1965—1977

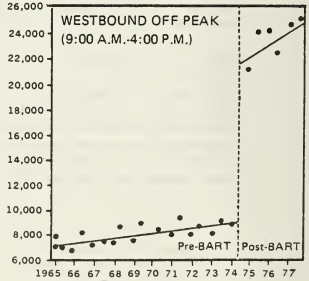
VEHICLE VOLUMES





TRANSIT PASSENGER VOLUMES





——— Trend Line

*Including transit travel through BART Transbay Tube in post-BART period.

Source: Ref. 28

EFFECTS ON BUS SERVICE AND RIDERSHIP

As previously mentioned, BART has attracted nearly half of its riders from buses. The system now accounts for roughly one-sixth of the total number of trips on public transit within the central Bay Area.

Until recently , there has been no centralized effort to integrate local transit service with BART or eliminate competitive lines. Adjustments have been made as a result of shifts in demand as transit travelers have changed from bus or streetcar to BART. This is a more passive process than rail/bus coordination in other areas, where bus routes competitive with rail were eliminated or truncated at rail stations. However, the adjustments which have been made in the Bay Area have permitted some parallel services to continue, allowing travelers to choose their preferred alternative.

About 61,000 of the trips now made on BART each day, 46% of the total, have been diverted from existing transit services. The 61,000 trips lost to BART have been substantially offset by travelers using MUNI and AC Transit to get to and from BART stations. Thus, the net reduction in bus trips is only 17,000 per day, as shown in Table 14.

TABLE 14

GAINS AND LOSSES IN LOCAL TRANSIT PATRONAGE

(1976)

Operator	Loss of "Line-Haul" Trips Diverted to BART From Parallel Services	Gain of "Access" Trips Using Feeder Services To Get To & From BART	Net Gain (Loss)
	One-Way Bus and Streetcar Trips per Day		
MUNI San Francisco Bus and Streetcar	23,000	17,000	(6,000))
AC Transit East Bay Bus	10,000	27,000	17,000
AC Transit Transbay Bus	19,000	---	(19,000)
Greyhound Transbay Bus	9,000	---	(9,000)
TOTAL ALL SERVICES	61,000	44,000	(17,000)

Source: Ref. 35

The access trips gained are generally much shorter than the longer trips lost, and produce a lower average farebox revenue per trip. The net patronage loss represents only about 3% of the combined current daily ridership on MUNI, AC Transit, and Greyhound, and is so small that it cannot be readily detected from time-series data on aggregate transit ridership.

Improved feeder bus service to BART in San Francisco has been provided by rerouting and increasing service on several MUNI lines, but generally bus services paralleling BART have not been downgraded to the degree recommended prior to the beginning of BART service (Ref. 35). MUNI service reduction proposals have been protested by both the general public and the bus drivers' union. To date, no MUNI line has been discontinued as a result of BART.

Similarly, the East Bay AC Transit service has been adjusted to improve feeder service to BART. In addition, BART now contracts with AC Transit to operate five BART express bus routes between BART stations and parts of the District beyond the immediate service area. On a handful of lines paralleling BART, AC Transit has reduced service.

Transbay AC Transit service was cut in response to losses of riders to BART. These reductions in the number of runs made during the peak amount to a reduction by 15% of AC's total scheduled bus-miles before transbay BART began. AC remains competitive with BART for transbay travel, especially where it can operate as a local collector in residential areas, and then as an express on freeways to downtown San Francisco. Bus service is generally somewhat less expensive than BART, and transbay express buses from the Richmond-Oakland area are often faster than BART.

Greyhound service in the transbay corridor has been appreciably reduced since BART service began in the corridor. Greyhound petitioned the Public Utilities Commission (PUC) to allow a cutback in their unprofitable transbay commuter service in 1974. The PUC permitted reductions only to the extent that demand diminished, and 80% of the Greyhound peak period vehicle trips have been eliminated as demand shifted to BART. Greyhound discontinued all of its off-peak service in the Concord corridor after transbay BART service began.

FOOTNOTES TO CHAPTER 4

(1) Ref. 13, p. 38.

(2) Ref. 14, p. 79

(3) Unless otherwise noted, all data in this section are from BART's monthly patronage reports, the BART data acquisition system (which reports trips between stations from the faregates), or the 1976 Passenger Profile Survey of weekday patrons.

(4) From Nov. 19 to Dec. 31, 1977 BART provided special service on Saturdays, for the holiday shopping period, at twenty-minute intervals on two routes, 8 a.m.-midnight. Regular Saturday service began January 1, 1978. Trains operate every fifteen minutes on three routes, 9 a.m.-midnight. By March, 1978, an average of 50 - 60,000 trips -- about 40% of the average weekday patronage -- was made on Saturdays. Expanded Saturday service, beginning at 6:00 a.m., and Sunday service began on July 1, 1978. Trains operate at 20-minute intervals on Sundays.

(5) The estimate of evening trips is provided to adjust for a possible bias caused by ending the survey at 3 PM.

(6) The five-county San Francisco-Oakland SMSA includes the three BART District counties plus San Mateo and Marin Counties.

(7) Network analyses cannot isolate the travel time differences due solely to BART since: (1) the with-BART network contains bus service which competes directly with BART in some instances; and (2) the with-BART network includes changes in the level of bus service from the no-BART case totally unrelated to the introduction of BART. Networks only approximate a peak and off-peak situation, but cannot be construed as wholly accurate representations of reality.

The with-BART network is a representation of the entire 1976 transit system including BART, its bus feeder services, and other bus and streetcar services in the area. Times derived from the network represent estimates of travel time and of time spent walking, waiting and transferring. In the network computations the greater service area was represented by a 239-zone subset of the 440 geographic zones into which the nine-county Bay Area is subdivided for transportation analyses. Each zone is designated by its centroid, a representative central point, and trips between zones follow a minimum-time pathway. The pathways do not necessarily include BART; and they may include travel by bus or streetcar to BART. Two versions of the with-BART network were analyzed, one representing morning peak-period services and the other representing the off-peak.

(8) The no-BART network is a representation of the hypothetical transit system judged to be the system most likely to have been in place in 1976 if BART had not been built. As in the with-BART network, travel times from the no-BART network represent estimates of the time it would take to travel between zones using walking, waiting and transfer times. Two versions of the no-BART network were analyzed, one representing morning peak-period transit services and one off-peak services. (See Chapter 1 and Appendix B for a description of the No-BART Alternative.)

(9) The highway network represents the 1976 system of streets and highways. Travel times from this network represent estimates of the time required to drive between zones (using the central point representing each zone) via the minimum-time path in the morning peak period. No off-peak highway network travel times were analyzed.

(10) (a) A survey of transbay travelers using BART, automobiles, and buses was made in 1974, about six weeks after BART transbay service began. Travelers were asked to rate their satisfaction with each of fourteen characteristics of each mode, and to indicate the importance of each factor in their mode choices. (Ref. 34)

(b) A telephone survey of persons living near four BART stations was made in 1975. Travelers reporting using buses or automobiles were asked their reasons for not using BART. This was the "BART Impact Travel Survey" by West Coast Community Surveys for MTC and the University of California, Urban Travel Demand Forecasting Project. Stations studied were Walnut Creek, Fruitvale (in Oakland), 24th St. Mission (in San Francisco), and Daly City. (Ref. 38)

(c) The 1977 workplace survey queried persons who work within a short distance of BART stations. The survey area included the destinations of virtually all work trips made on BART. Respondents were asked their reasons for their choice of travel modes. (Ref. 38)

(11) All data in this section are from the May 1976 BART Passenger Profile Survey unless otherwise noted.

(12) Persons of Spanish heritage appear to be under-represented on BART. However, the Spanish heritage population is particularly difficult to define. The U.S. Census defines Spanish heritage in terms of Spanish language and surname. Respondents to the BART Passenger Profile survey were asked to classify themselves in terms of the ethnic or racial category most appropriate. This allowed persons of Spanish heritage to classify themselves as either "White" or "Spanish" -- both appropriate categories.

(13) Data shown in Figure 16 and Table 13 are for the westbound traffic direction, averaging spring and fall data for 1973, before BART transbay service began, with spring and fall data for 1977.

(14) The rate of diversion from autos is greater for the BART system as a whole than for the transbay segment alone. As described earlier, about 55% of BART patrons who had made their BART trips by another mode prior to BART service had used automobiles.

CHAPTER 5

INDIRECT IMPACTS OF BART'S TRANSPORTATION SERVICE

The impacts which result from the use of BART generally affect residents and neighborhoods near the lines and stations. Few area-wide social or environmental impacts have occurred. BART does not create new travel patterns for the vast majority of Bay Area residents, and for this reason its impacts on the life styles of its patrons are limited. However, for persons without access to an automobile, especially young people, it has increased mobility and expanded the geographic range of travel. Adverse impacts on neighborhoods around heavily used stations have occurred where traffic has increased and where inadequate parking space is provided.

BART's operations are relatively pollution-free. The use of BART is expected to result in a decrease of about 3% in the region-wide pollutant emissions of automobiles when the system is operating at full service levels. BART is also an energy-efficient transportation mode, in comparison with automobiles. Moreover, as an electrically-powered system it can use energy from sources other than fossil fuels. This flexibility may become a significant advantage to the Bay Area in the future if petroleum shortages are experienced, and if alternative power sources are developed.

IMPACTS ON LIFE STYLES

BART planners, in their descriptions of anticipated benefits of BART, characterized mobility as the key to expanded contacts and experiences and to improvements in the quality of life. The "Composite Report" predicted, "Rapid Transit will enable the people of the area to make better contact with the expanding physical and social environment in which they live..." and, "The leisure-time 'mix' for the typical Bay Area resident can become much more varied and meaningful." (Ref. 14)

For the purposes of studying these potential impacts of BART, a small group of BART patrons was selected to form a panel of respondents. The panel members were interviewed intensively to determine the nature and extent of the effect of BART service on their life styles. Although some users report that BART makes a difference in their lives, most say the effects are small. BART is an alternative means of transportation which represents a new travel experience but not a new opportunity for travel for people with access to an automobile or to good bus service. For people without such access, BART has larger significance.

EFFECTS ON WORK ROUTINES AND LIFE STYLES OF COMMUTERS: The most consistent and widespread life style impacts of BART are its effects upon the work routines and the work-related experience of its regular commuters. For some commuters, BART has altered the timing and scheduling of work trips; this sometimes means moving back the time of morning departures to work ten to thirty minutes because of the unreliability of the BART system. Others, those with more flexible work schedules, have changed their working hours to avoid rush-hour crowding on the trains. Respondents, however, had difficulty identifying what

actual reorganization of routine activities they implement to accomplish these schedule changes.

Commuters report looking forward to the BART ride as an opportunity for reading novels, newspapers, or magazines. Over half of regular BART commuters among the panel report that use of the system leaves them more relaxed when they return home. They compare it favorably to the frustrations of rush-hour automobile travel and speak of it as a time to think things through or a period of relaxation between home and work. For some commuters, the time provided for activities on BART results in real economies. About one-eighth of the panel report doing work on BART such as ordering their schedules for the day's activities or reading correspondence and professional journals.

Some commuters, particularly those with fixed work schedules, have gone back to using a bus or car for work travel because BART service has not been reliable. However, most of the panel members continued to ride BART. They reported experiencing frustration and anger when first using BART for work trips because of the system's unreliability. However, over time this discontent for some turned to resignation, and for some to an enjoyment of the time provided for their chosen activities.

For a small segment of commuters, BART encourages more side trips for visiting, shopping, or having an evening out in connection with the trip from work to home. This is most prevalent among single persons dependent on public transit.

EFFECTS ON STUDENT LIFE STYLES: BART's impacts on the lives of college students who use it range from the trivial to the significant. For many, BART is perceived simply as a convenient alternative to bus or auto travel. BART has enabled a few students to live farther from the campus than would otherwise be possible, and thereby to lower their housing costs. BART makes attendance at a college possible for a limited number of persons who do not have access to autos or bus services.

EFFECTS ON NON-WORK ROUTINES: BART is not generally chosen by car owners for trips for recreation, shopping, visits, entertainment events and other non-work trips. Some persons who are dependent on public transportation report altering their schedules to take advantage of BART's service for discretionary trips. Teenagers and children broaden their knowledge of the region by riding BART. Some use the system for activities which contribute to their cultural knowledge.

BART generates some shopping trips to downtown San Francisco and Oakland. These trips are often made by groups of friends or relatives, and are sometimes open-ended excursions in which the BART ride itself is part of the enjoyment. The BART system is also a tourist attraction. Persons interviewed report that they have taken out-of-town visitors for rides on the system.

EFFECTS ON THE FAMILY: In one-car families the use of BART often involves careful scheduling to permit a non-working person to drop off and pick up a working member of the family. This is often difficult because of the unreliability of BART; as a result, household routines are

sometimes interrupted. However, the availability of an automobile for the non-working family members increases their freedom of movement.

Some of the families report decreased auto costs as a result of BART service. A few of these have been able to function with one car rather than two, or to defer the replacement of an existing car.

EFFECTS ON YOUNG PEOPLE: Young people between the ages of nine and eighteen are enthusiastic BART riders. For them, the system is an important way to get to recreation and cultural events, to go to school, and to visit friends and relatives. Many use BART for Oakland Coliseum athletic and music events. An unexpectedly important use of BART for young people is for visiting relatives. Fourteen percent of all trips on BART by young interviewees were for this purpose; 6% of their trips were to visit a parent who was separated from the spouse with whom the child was living. Young people reported that BART provides freedom from the supervision of parents and independence from the need to be chauffeured by them. They regard BART as a safer, more pleasant, more enjoyable service than that provided by buses.

IMPACTS ON INSTITUTIONS

It was anticipated that the accessibility provided by BART might produce changes in the clientele and staff of social institutions and alter the administration, functioning, or community life of such institutions. Health care institutions and institutions of higher eduction located close to BART were studied to determine whether BART had any such effects.

HEALTH CARE INSTITUTIONS: BART has a negligible effect on health care institutions because most patients prefer to use an automobile to get to a hospital or clinic. The availability of public transportation does not appear to have a significant influence on decisions to seek or not to seek health care, or on the choice of a facility. Use of BART by the institutional staff was also found to be limited. Therefore, few changes have occurred.

HIGHER EDUCATION INSTITUTIONS: BART's impacts on institutions of higher education vary. They depend on the type of institution, the location, and administrative policy. For instance, both the University of California in Berkeley and Mills College in Oakland have made deliberate efforts to reach commuting students by establishing special BART feeder services. U.C. Berkeley has an enrollment of 30,000. BART is the primary access mode for about 8% of the total student body, but it serves 22% of those who live three miles or more from campus. At Mills College, however, efforts to encourage the use of BART and feeder buses have had negligible results. BART serves a population of working commuters who attend Golden Gate College in downtown San Francisco. They use the system to travel to work and to attend night classes after work.

The impacts of BART service on the nature of the student body or on the functioning of an institution are difficult to determine. BART does support the prevalent "commuter-vocational" campus life style which has

developed among students at many Bay Area colleges. This life style is characterized by minimal commitments and contacts between the institution and its students. At U.C. Berkeley, BART service may be contributing to some dispersal of the student community. However, the major motivating factor is probably the fact that housing is less expensive and easier to find at some distance from the campus.

IMPACTS ON NEARBY RESIDENTS AND NEIGHBORHOOD STREETS

A number of localized impacts result from BART patrons traveling to stations, parking their cars, and from trains passing through residential neighborhoods. They generally affect only the persons in the first row or two of houses adjacent to the facilities. Most of the impacts are nuisances such as the inconvenience caused by BART patrons' cars parked on residential streets and increased traffic on streets near the stations. A few persons living near BART facilities have complained of increases in local air pollution and traffic accidents as a result of patrons' travel to stations.

A sample of persons living within one to four blocks of BART facilities was questioned about their perceptions of the local impacts of the system's use. The interviews were conducted in ten neighborhoods; seven were near BART trackways, two were near heavily-used BART stations, and one adjoined a lightly-used station. In addition, data were collected to provide objective measures of factors such as local air quality and traffic safety.(2)

The only adverse impact reported by residents near the trackways (apart from the noise of trains, which is an impact of the facilities discussed in Chapter 3) was a loss of privacy; this occurred only where homes were directly adjacent to the above-ground trackways.

Residents near heavily-utilized stations had complaints about a number of impacts. Table 15 shows the responses of persons near two heavily used end-of-line stations (Daly City and Concord) and one lightly used mid-line station (El Cerrito) to BART's effects on air quality, traffic safety, parking, and crime in the neighborhood. There is a low level of dissatisfaction with the local effects of BART among residents near the El Cerrito Station. This is explained by the station's moderate patronage (about 1,500 round-trips per day) and a relatively small parking lot (800 cars) which is not overfilled. The station is adjacent to a major shopping center with a large parking lot which was opened prior to the beginning of BART's operations; thus local residents had adjusted to any traffic and parking problems before BART service began.

Both the Daly City and Concord stations are heavily utilized. About 5,000 round trips per day are made at Concord, and 9,000 at Daly City. The parking lots at Daly City and Concord had space for about 1,000 cars at the time of the survey. A number of residents at these station sites reported being unhappy with BART's impacts on parking, traffic safety, crime and air pollution.

TABLE 15

RESPONSES OF RESIDENTS NEAR THREE BART STATIONS TO THE INDIRECT IMPACTS OF BART'S TRANSPORTATION SERVICE

STATIONS	P E R C E N T O F R E S P O N S E S (3)					
	Impacts on Parking			Impacts on Traffic Safety		
	"Happy"	"Indifferent"	"Unhappy"	"Happy"	"Indifferent"	"Unhappy"
Concord	0	24	76	2	51	47
Daly City	0	23	77	8	54	38
El Cerrito	17	78	5	14	77	9
	Air Pollution Nearby			Crime Near Home		
	"Happy"	"Indifferent"	"Unhappy"	"Happy"	"Indifferent"	"Unhappy"
Concord	3	89	8	3	79	18
Daly City	8	67	25	22	66	12
El Cerrito	10	85	5	14	82	4

Source: Ref. 21

PARKING: Heavy on-street parking due to the BART parking lot overflow is the most severe problem perceived by residents in neighborhoods adjoining both the Daly City and Concord BART stations, as shown in Table 15. At Daly City, where heavy overflow parking was severe, a new parking structure was recently built, increasing the capacity to 1,600 cars. Additionally, feeder bus service to the Daly City Station has been expanded, and preferential parking for residents has been implemented. These changes have alleviated but not eliminated the problem of overflow parking at the Daly City Station site.

LOCAL AIR POLLUTION: As Table 15 indicates, persons living near stations with overflow parking problems tend to attribute other negative effects to the BART-related increase in neighborhood traffic, such as decreased traffic safety and increased local air pollution. In the case of air pollution the perceptions are contradicted by measurements of the effects. Direct measurements of the carbon monoxide levels around BART stations show little difference between present levels and those which are likely to have occurred if BART had not been operating. One reason is that the winds prevailing in the Bay Area quickly disperse any pollutants which might accumulate as a result of the use of automobiles and buses to get to the stations. At Daly City an adjacent freeway could be contributing some of the pollutants attributed by residents to

BART-related traffic.

SAFETY: Neighbors' perceptions of BART's impacts on traffic safety are partially supported by measurements. The increase in auto traffic near a few heavily used stations such as Daly City and Concord have caused some local congestion and an attendant small increase in the frequency of accidents.

A significant BART-related increase in accidents involving collisions with parked cars (from one or two before BART to eight or ten after BART in similar time periods) involving parked cars was found only near the Daly City Station where the commuter traffic and on-street parking is particularly heavy on the two-lane residential streets in the area.

SECURITY: Local law enforcement officials report no increase in crime near BART stations since operations began, and the majority of residents near the BART stations do not think BART has resulted in any increase in crime in their neighborhoods.

PRIVACY: The loss of privacy was found to be an adverse impact affecting residents near BART elevated trackways which overlook residential backyards. A loss of backyard privacy is most often felt by persons living directly adjacent to elevated trackway and to a lesser extent by residents along at-grade lines. However, there were few reports of actions in response to the exposure (e.g., fences, window covering), and loss of privacy was seldom rated among the "worst" of BART's impacts. Residents' ratings of this impact are shown in Table 16.

OVERFLOW PARKING FROM DALY CITY STATION

TABLE 16

RESPONSES OF RESIDENTS NEAR BART LINES TO
BART'S IMPACTS ON THEIR PRIVACY

Elevated Line Sites	Percent of Respondents: Backyard Privacy "Good"	Backyard Privacy "Indifferent"	Backyard Privacy "Bad"	Privacy Inside Home "Good"	Privacy Inside Home "Indifferent"	Privacy Inside Home "Bad"	Total No. Respondents
Albany E.	0	77	23*	1	89	10	118
Albany W.	5	77	18	7	75	18	43
Oakland	2	94	4	2	90	8	52
Hayward N.	0	80	20*	0	82	18	51
San Leandro	0	71	29*	0	89	11	49
At-Grade Line Sites							
Richmond	2	88	10*	3	92	5	88
Hayward S.	4	86	10*	4	92	4	50

* The percentages shown here represent respondents living within about four blocks of the site. The proportion of persons living within one and one-half blocks of the BART line at these sites who reported adverse effects on privacy was substantially higher than that shown here. BART's perceived effects on privacy inside the home were small among residents near the trackway as well as among those at a distance of two to four blocks.

Source: Ref. 21

IMPACTS ON REGIONAL AIR QUALITY

Air quality was not a prominent issue in the Bay Area when the voters authorized funding for BART in 1962. However, a heightened awareness of the problem of air pollution emerged in the latter part of the 1960's and there is evidence that by 1972 Bay Area residents expected BART to help alleviate the problem. An inquiry into public expectations of BART which was made in 1972 showed that 62% of the persons questioned thought that the system would substantially improve air quality.(4)

However, BART cannot have the significant impact anticipated because the system's patronage is minor compared with the total number of trips made in its service area. BART now carries 2.4% of all weekday trips made by residents of its three-county district. Even at full service levels, BART will probably carry only about 5% of the trips made. Therefore, the maximum theoretical impact the system could have on emissions of air

pollutants would be a reduction of 5%. The actual reduction in emissions at full service levels will be about 3%, however. There are two reasons for this: (a) some BART patrons formerly traveled by bus, not automobile; and (b) some patrons use automobiles to travel to and from BART stations. Since most pollutants caused by local trips are generated when an automobile is started and stopped, the length of the trip has little effect on pollutant emissions.

BART does provide a relatively pollution-free alternative to the automobile. The pollution created in the production of energy for BART operations is negligible compared with the reduction in pollution from automobile emissions which is expected to occur when BART reaches full service levels of operations. This comparison is shown in Table 17. Table 18 shows the positive BART impact on regional air quality and the Environmental Pollution Act (EPA) required reductions to achieve the national ambient air quality standards for the three-county BART District.

TABLE 17

BART-INDUCED POLLUTANT REDUCTIONS AND PRODUCTION
Pounds Per Day

Pollutant*	BART-Induced Reduction	BART-Induced Production
CO	64,000	13
RHC	10,000	96
NOx	8,000	2,430

TABLE 18

BART-INDUCED POLLUTANT REDUCTIONS AND EPA-REQUIRED REDUCTIONS
Tons Per Day

EPA-Required Reductions*		BART-Induced Reductions	
CO:	504	CO:	32
RHC:	131	RHC:	5
NOx:	None required	NOx:	4

*CO=Carbon Monoxide: RHC=Reactive Hydrocarbons: NOx=Oxides of Nitrogen

THE IMPACTS OF BART'S ENERGY USE

Private automobiles dominate urban travel largely because gasoline has been cheap and readily available. The oil embargo of 1973-1974 underscored the nation's dependency on petroleum and the automobile for meeting transportation needs. It also produced a heightened awareness of the potential role of public transportation in reducing that dependency. Neither BART nor other urban transportation systems have been designed specifically to accomplish energy conservation goals, but electrically-powered systems such as BART have an important

petroleum-saving feature; their power can be derived not only from petroleum but from alternative sources, such as hydroelectric, coal, or nuclear. This flexibility to substitute alternative energy sources represents a unique advantage of electrically powered systems which may become more important if petroleum shortages are experienced, and if alternative energy sources are developed.

BART'S ENERGY USE-- HISTORY AND TRENDS: BART currently requires an average of 0.45 kilowatt hours of electrical energy for each passenger-mile of travel. Traction energy, the energy from the third rail which propels, lights, and air conditions BART vehicles, currently represents 71% of the total operating energy requirement. The remaining 29% is energy used to operate and maintain stations, yards, shops, and the Administration Building, and to ventilate the Transbay Tube and the Berkeley Hills tunnel. The energy required for stations and maintenance has decreased as a proportion of total system energy use as BART operations have expanded. This trend is expected to continue until full service operations are achieved.

BART's energy requirement for each car-mile and passenger-mile of travel has decreased annually since revenue service began. In the four-year period between 1973/74 and 1977/78 the number of passenger-miles traveled annually on the system quadrupled and the number of vehicle-miles operated tripled, but total energy use increased by only 72%. In 1977-78 the system's energy consumption decreased in absolute terms for the first time since revenue service began. Service was expanded to include Saturdays, the number of car-miles operated increased 5% over the previous year, and the number of passenger-miles of travel increased 11% while at the same time energy consumption decreased 7%.

BART's increased energy efficiency is largely attributable to two factors: (a) Although the system's energy consumption has increased as hours of service and capacities have been expanded, the service expansions have generally required only marginal additions to the BART facilities. Therefore the fixed portion of energy requirements has been spread over a larger number of vehicle-miles and passenger-miles of travel. (b) Two operating policies implemented in recent years are designed explicitly to conserve energy and reduce operating costs:

(1) In 1976 a decison was made to reduce the length of trains during off-peak travel periods to more closely match travel capacities and travel demand. As a result the number of empty seats on BART vehicles declined, and the amount of energy required for each passenger-mile of travel was reduced.

(2) In mid-1977 a decision was made to deactivate the auxiliary air conditioning and lighting systems on BART vehicles when the vehicles were not being used for operations. Prior to that time these systems had remained activated at all times except when the vehicles were in the shops for major repairs to facilitate the beginning of service operations each day. This change in policy is primarily responsible for the decreased energy requirements in 1977-78. A decrease in train speeds which was implemented in 1977-78 also contributed to the decrease in energy use by decreasing periods of acceleration. Train speeds were

decreased in response to California Public Utilities Commission requirements to provide for increased operational safety when trains are run at more frequent intervals, an improvement in service expected to be implemented within the next few months.

These new operating policies, in addition to the increased patronage on the system, have resulted in a 20% decline over a three-year period in the energy required for each passenger-mile of travel, as shown in Table 19.

TABLE 19

BART ENERGY USE: HISTORY AND PROJECTIONS

	TRACTION ENERGY USE			TOTAL ENERGY USE		
Fiscal Year	Total MWH	KWH Per Car-Mile	KWH Per Passen-ger-mile	Total MWH	KWH Per Car-Mile	KWH Per Passen-ger-mile
1975/76	165,144	7.36	0.40	228,742	10.19	0.55
1976/77	169,666	7.42	0.38	235,502	10.30	0.53
1977/78	156,338	6.50	0.32	219,816	9.14	0.45
1980/81*		6.00	0.29		8.00	0.39

*Projections for 1980/81 are based on BART District estimates. (MWH=Megawatt-hour; KWH=Kilowatt-hour)

Source: BART District Records

BART's energy use per unit of service is expected to decline in the future, as shown in the foregoing table. The major contribution to the decline will be made by BART's regenerative braking system, which is designed to return power from decelerating to accelerating vehicles. To date it has been largely ineffectual because of the relatively large spacing between trains and because the power supply has been separated into relatively short "blocks." When the system is modified so that energy can flow between "blocks," and when trains are run more frequently, the regenerative braking system will reduce net external power requirements.

BART'S ENERGY EFFICIENCY COMPARED WITH AUTOS AND BUSES: Table 20 compares the traction energy efficiency of BART, buses and automobiles. It shows two figures for BART energy use in terms of equivalent amounts of gasoline; the first figure applies to electrical energy derived entirely from fossil fuels, and the second to electrical energy generated from a mixture of fuel sources -- hydroelectric, nuclear, geothermal and fossil -- which make up California's generating capacity.

TABLE 20

ENERGY EFFICIENCY OF BART, BUSES, AND AUTOMOBILES

Travel mode	Traction Energy Efficiency (Equivalent Gallons of Gasoline)	
	Passenger-miles Per Gallon	Seat-Miles Per Gallon
BART*		
1977	42;59	148;209
1981	46;65	160;226
Automobiles**	19	67
Buses***	48	191

*The first figure is calculated on the assumption that 10,000 Btu's are required to produce one kwh of electricity; the second figure is based on the assumption that 7,095 Btu's are required. (5)

**Assumes 13.5 miles per gallon and 1.4 passengers per automobile, the characteristics of urban commuter automobiles described in the 1975/76 American Public Transit Association (APTA) Transit Fact Book. Also assumes one gallon of gasoline requires 133,800 Btu's for production and distribution.(6)

***Assumes 4.4 miles per gallon of diesel fuel, the average for Bay Area buses; twelve passenger-miles per vehicle-mile, and 48 seats per bus. Also assumes one gallon of diesel fuel requires 147,800 Btu's for production and distribution.(6)

As the table indicates, BART operations are about three times more efficient than urban automobiles in terms of energy use per passenger- and seat-mile of travel. BART operations are generally similar in energy efficiency to those of buses.

It should be noted that the comparisons are heavily dependent on the assumptions used in the calculations, which are described in footnotes to the table. The energy efficiencies of each mode are particularly sensitive to assumptions about load factors (the number of persons in each vehicle). For instance, a fully-occupied BART train during peak travel periods is many times more energy-efficient than most commuter automobiles which carry only one or two persons.

It is evident from the foregoing discussions that BART provides an energy-efficient alternative to automobile travel, in terms of traction energy use. The total impact on the energy used for transportation in its service area is dependent on a number of factors which have not been measured, or which cannot be assessed at this early period of BART's operations. A comprehensive analysis would include measures of the energy

used for BART's construction as well as its operations. It would also include a comparison of the length, incidence, and mode of trips to and from BART stations with their likely alternatives. A major component of a comprehensive analysis would be an assessment of the long-run impacts of BART on land use and urban development. If BART, or rail systems elsewhere, are instrumental in reducing urban sprawl in the long run, the resulting energy savings could be significant. However, BART's effects on land use, described in Chapter 6, have not yet markedly changed the distribution of activities in the Bay Area.

BART has resulted in an increase in the transit share of trips in the corridors it serves. Therefore, a decrease in the rate of growth of energy use can be attributed to BART, but its extent is minimal on a regional scale.

FOOTNOTES TO CHAPTER 5

(1) The environmental and social impacts of the use of BART are discussed in this Chapter. Impacts on land use and economic development are discussed in Chapter 6, and the impacts of BART facilities and operations (apart from the use of the system by patrons) are discussed in Chapter 3. (See the description of the "impact process" in Appendix B for an explanation of the organization of the study.)

(2) Wayside Response Survey (ref. 21).

(3) Total number of respondents: Concord, 96; Daly City, 50; El Cerrito, 103. The figures show the percent of all responses of persons living near each site. Response categories have been combined; "happy" combines categories "very happy" and "fairly happy," for instance.

(4) Pre-BART Urban Residential Survey (ref. 19).

(5) State of California, Department of Transportation. Memorandum dated March 28, 1975 (File 503.2). Released by the National Technical Information Service.

(6) M.F. Fels and M.J. Munson, "Energy Thrift in Urban Transportation Options For the Future." Energy Conservation Papers, the Ford Foundation; 1975.

CHAPTER 6

LAND USE AND URBAN DEVELOPMENT IMPACTS OF BART

SUMMARY

BART has affected the spatial distribution of activities in the Bay Area in a number of ways. In some cases it has influenced urban development patterns directly through its service and physical effects. In other instances BART has been a catalyst for public policies and projects which have worked together with the system's direct effects to influence land uses. Many other factors have also been important in shaping Bay Area urban development patterns. They include the price and availability of land, the extensive system of freeways and highways, and alternative public transportation services. In other words, BART has been one component of forces influencing individual location and investment decisions which, in turn, give rise to urban development patterns.

BART's primary impacts to date have taken place at the local, rather than the regional level. For example, population and employment have not increased in the BART District at the expense of other Bay Area counties. Nor has the system caused a redistribution of office space on a regional level. However, within the greater BART service area (the three BART District counties and northern San Mateo County) employment has increased most rapidly in the relatively narrow corridors along the BART lines. Some employers have located their businesses in BART station areas in part, at least, because of BART. BART has encouraged some firms to remain in the city centers, and in this manner BART may be helping to maintain the economic stability of the Bay Area's traditional city centers.

Within a number of cities served by BART the system has been both a direct and indirect cause of a shift in new office construction to its station areas. For example, in downtown San Francisco over 90% of the 22.5 million square feet of office space built since 1965 is within 1,500 feet of the four downtown BART stations. Two events primarily attributed to BART, a $35 million Market Street Development Project and new zoning codes adopted by the city, have contributed to the redirection of growth.

Office construction in BART station areas has also increased in the cities of Oakland, Berkeley and Richmond. The total amounts of new office space in these cities has been much smaller than that which was added in San Francisco. About two million square feet of major new office space has been added in downtown Oakland since 1965. About 1.5 million was built within 1,500 feet of the two downtown Oakland stations, and BART was one factor which influenced the location of 80% of this new space. Another major influence was the City Center redevelopment project, which is located at the site of BART's 12th Street Station. BART enabled the project to be expanded because funds spent for the BART station were used as part of the local credits to obtain matching federal funds. Therefore, BART's influence on the location of office space in downtown Oakland has been both direct--the result of its service and facilities--and indirect--the result of the City Center project which is, in turn, partially attributable to BART.

BART's influence on housing construction has been less pronounced than its influence on office construction. No high-density nodes of residential development have occurred around the BART stations. This is

due, in part, to public policy decisions. Nine residential or mixed residential and commercial areas around BART stations were downzoned in response to residents' wishes to preserve the existing character of the neighborhoods. By contrast, zoning regulations have generally encouraged commercial development around the downtown city BART stations. In addition the continued preference for single-family homes in suburban communities has discouraged high density developments. Nevertheless, the system has had decided impacts on development decisions; 2/3 of twenty-six housing developers who were interviewed said BART was an important factor in their location decisions.

Residential developers indicate that BART has heightened the demand for housing in two East Bay suburban areas which were considered to be beyond commuting distance to San Francisco and Oakland prior to BART service. While BART has had some effect on suburbanization, affecting both supply and demand, it cannot be considered a major factor. The new suburban developments would very likely have occurred even without BART, given the scarcity of developable land near the central cities and the completion of several major highway improvements serving the suburban areas.

Retailers have largely disregarded BART in their location decisions. Other kinds of transportation have been more important than BART in influencing their decisions -- for example, automobiles in suburban areas, and buses and streetcars in central city downtown areas. BART station sites in downtown areas in Oakland and San Francisco are well served by buses and streetcars, making it difficult to distinguish a BART impact from the effects of other transportation services. (It should be noted that BART had been providing Saturday service for only a brief period of time when this study was made. Long-term BART service on Saturdays may eventually increase its importance to shoppers and to retailers.)

Property price gains attributable to BART have been small, to date. The Program's findings do not support the theory that a rapid transit system is likely to cause large increases in the price of properties near its facilities which could be taxed to help pay for the system. BART's effects in this regard have been too small to be a useful source of financing for the system. However, it should be recognized that BART has no entrepreneurial authority which would permit it to exploit the potential it creates.

To date, BART's effects on behavior patterns have been more pronounced than its overall effects on the location of offices and homes. Surveys have shown that of those workers who had recently changed or obtained jobs, one in four had sought the job with the intention of commuting by BART. Although a job's location is not usually the primary factor in an individual's job choice, the desirability of any given work location is often a function of BART accessibility. Surveys have also shown that BART may be causing a shift in shopping patterns toward downtown San Francisco, downtown Oakland and Walnut Creek. Finally, BART is becoming a common decision factor among people who have decided to move in the choice of where to move.

BART's influence on peoples' choices of residence, workplace and shopping locations suggests that its most significant impacts on land use and urban development may occur in the future. If BART continues to influence behavior patterns some redistribution of homes, workplaces and shops is likely to result. Moreover, BART's relative attractiveness as a transportation mode can be expected to grow as its service and reliability improve and as the highways, particularly the bridges into San Francisco, become more congested. BART is then likely to become more important in the location decisions of both individuals and businesses.

Finally, large-scale land use changes tend to occur slowly. Therefore, it may be too soon to expect substantial land use impacts as a result of BART.

LAND USE PLANS AND POLICIES

The context for BART's impacts on land use and urban development was partially established in decisions made during the planning for the location of the facilities. Public policies in regard to zoning, development incentives, civic improvements and redevelopment projects have also been important determinants of the system's impacts.

Most of the conceptual decisions which determined the general location of BART in the Bay Area were made very early in the planning process, beginning with general plans developed in 1952-1956. The system was intended to serve existing and forecast centers of population, to supplement existing highway capacities, and to connect urban subcenters to the major metropolitan areas. Although BART was expected to lead to increased developments in areas around its facilities, some lines and stations were placed in communities with little development potential. (See Chapter 2 for a further discussion of these issues.)

In general, local communities did not become actively engaged in the planning process until the BART bond issue had been passed in 1962. After that time most of the communities to be served conducted special BART station area or corridor studies, and the projections of new developments which generally resulted from these studies served to arouse citizen interest (and sometimes apprehension), about changes which were expected to occur in their neighborhoods. Many small communities began to make comprehensive land use plans for the first time, as a result of expectations of BART's impacts.

Planners in both San Francisco and Oakland developed and revised public projects in anticipation of BART. San Francisco initiated a $35 million Market Street Development Project, and implemented plans to place Market Street streetcar lines underground as part of the BART construction project. At the time BART was planned, the street was run down, ugly, and neglected. Pinball establishments and peepshows lined portions of the street, and the manufacturing - wholesaling - skid row image of the area south of Market Street was a deterrent to new office construction. The development project has made the street attractive and it is now a prime business location.

In Oakland, BART was instrumental in increasing the size of the downtown City Center Redevelopment Project. This project had been planned as a small, six-block project to cost $4 million. It was expanded to a major, $24.5 million project by incorporating the 12th Street BART Station, which permitted the use of the funds for the construction of the station as local credits for matching federal funds. Also, Oakland initiated a $1 million street beautification project in the downtown area, using BART construction funds to increase available local credits.


BONANZA
CENTRAL SAVINGS
BRATE

Zoning and incentives policies were enacted to encourage development around downtown BART stations in both San Francisco and Oakland. In San Francisco, floor area ratio (FAR) bonuses were allowed for buildings with direct connections to BART stations and for new buildings close to BART, and fewer parking spaces were required to be provided in connection with buildings which were built near the stations. Height and bulk limits were changed to permit the highest buildings to be built in the area surrounding the Montgomery Street BART Station. In downtown Oakland, by contrast, zoning provisions already exceeded the general level of development, and although the requirements were changed to include incentives for station area development and disincentives to development elsewhere, developers have often been granted variances to locate at some distance from BART.

As the map in Figure 18 illustrates, changes in zoning and land use policies were made in twenty-six of the thirty-four BART station areas. In fifteen cases the changes represented less restrictive regulations, permitting higher density developments. In nine cases the zoning was made more restrictive. In general, these were areas of mixed commercial and residential uses. For instance, in the Mission District in San Francisco, where strong community organizations blocked redevelopment plans for the Mission corridor, rezoning reduced allowable densities. Similar community pressures to preserve the character of neighborhoods resulted in the downzoning of station areas in Berkeley and in the Rockridge District of Oakland.

BART'S IMPACTS ON COMMERCIAL DEVELOPMENT DECISIONS

ECONOMIC GROWTH: BART has affected the distribution of new office space and the decisions of some employers about where to locate within the three-county District. However, it has not, to date, served to attract new businesses to the area; the growth of the region as a whole, as distinguished from shifts in the location of activities within the region, has not been affected. The San Francisco Bay Area is highly regarded as a place to live and work, and BART was built to serve the growth which was occurring in the 1950's and 1960's and which was expected to continue. For this reason BART is, in part, a consequence of a favorable economic climate.

To assess BART's impacts on the region's overall growth, employment shifts in 66 Bay Area industry groups were compared with shifts in comparable industry groups in other major metropolitan areas around the country. Employment growth in the three-county BART District was also compared with the experience of the nine-county Bay Area.

This analysis indicated that five industry groups in the Bay area--government, central office activity, services, financing and manufacturing--have grown faster than can be explained by national or industry trends since 1962. Moreover, employment growth in the San Francisco central business district was proportionately greater than that in the nine-county Bay Area between 1960-1975, a fairly unusual phenomenon in American cities in recent years.

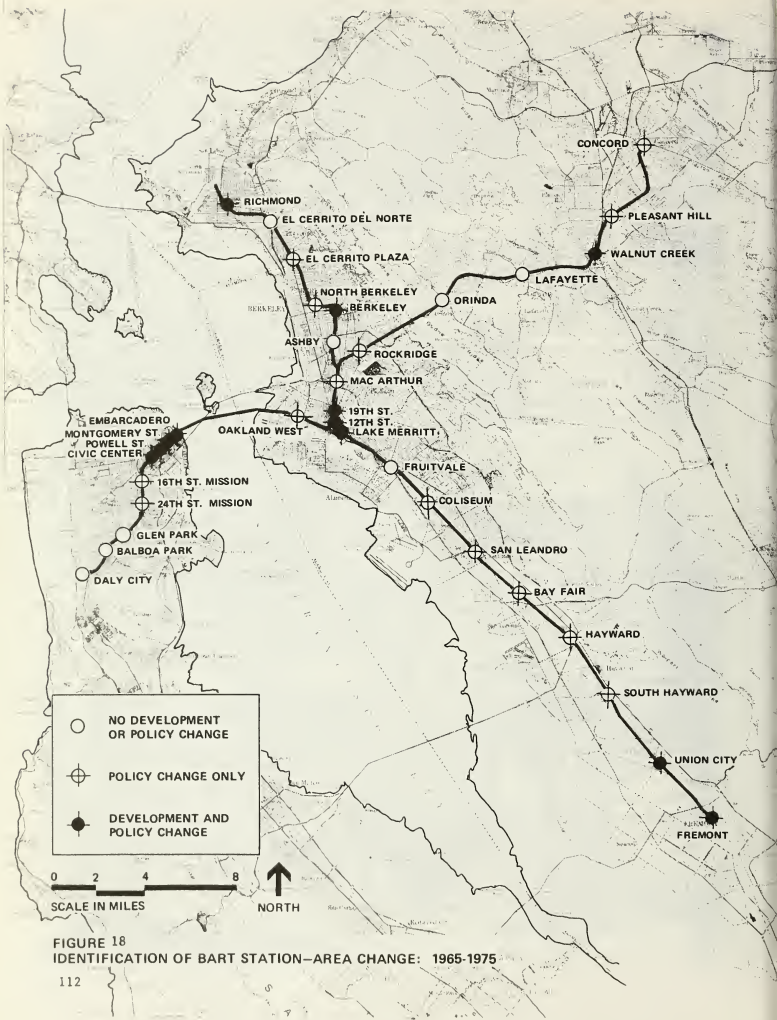


FIGURE 18
IDENTIFICATION OF BART STATION–AREA CHANGE: 1965-1975

Representatives of businesses in the sectors of economic activity showing high rates of growth and persons knowledgeable about business location decisions were interviewed to determine whether the increases in employment were due to BART service. None mentioned BART as a reason for business decisions to locate in the BART District rather than elsewhere, although some cited intangible impacts such as improved "image" from locations near BART.

The interviews revealed that public transportation in general, and BART in particular, were minor factors in most employers' locational choices. BART has not induced firms to leave one city for another. It has not caused businesses to return to the older central cities, or encouraged movement to the suburbs. However, BART has influenced a few central city firms to remain in the central cities, thereby helping to forestall decentralization and to maintain the preeminence of the Bay Area's traditional city centers. To date, BART has influenced at least one employer in San Francisco and three in downtown Oakland to remain in the central cities rather than to move to outlying locations. As congestion worsens in the future, BART's transportation capacities in corridors leading to the central cities are likely to become more important, and its role in forestalling decentralization could increase.

BART has been a more important factor in the location decisions for federal and state offices than for private businesses. Three of five governmental agencies contacted reported that BART had influenced their location decisions, while less than 5% of the private firms reported a BART influence. This is probably due to the fact that transit access is a major site selection criterion for governmental offices. BART has influenced the decisions for public offices in Fremont, Richmond and Oakland. With one exception (the Social Security Administration in Richmond), major employers have not been influenced by BART to locate in station areas in economically declining communities. This observation suggests that in the absence of existing demand for new commercial space a rail transit system will not induce such development.

NEW OFFICE CONSTRUCTION:(1) the impact of BART on the location of new office construction within several Bay Area communities has been pronounced. This is particularly true in San Francisco, where since 1965, approximately 22.5 million square feet of new office space have been built or are currently under construction within 1,500 feet of the four downtown BART stations in the Market Street corridor. This represents over 90% of the new office space built in the central business district as a whole. Although BART's effects cannot be easily isolated from other influences affecting the location of office buildings, key informants indicated that BART was an important influence on decisions to locate about two million square feet, or about 10% of the new supply, near BART stations rather than elsewhere in the city. BART has contributed to a definite redirection of new office buildings toward Market Street, the transit spine of downtown San Francisco where the BART stations are located. The Market/south-of-Market area has experienced a dramatic rise in the share of the downtown's new office development, from virtually none before BART (1960-1962) to 88% during BART's operations (1974-1977). This shift is illustrated in the maps shown in Figure 19. Two events primarily attributable to BART, the $35 million Market Street

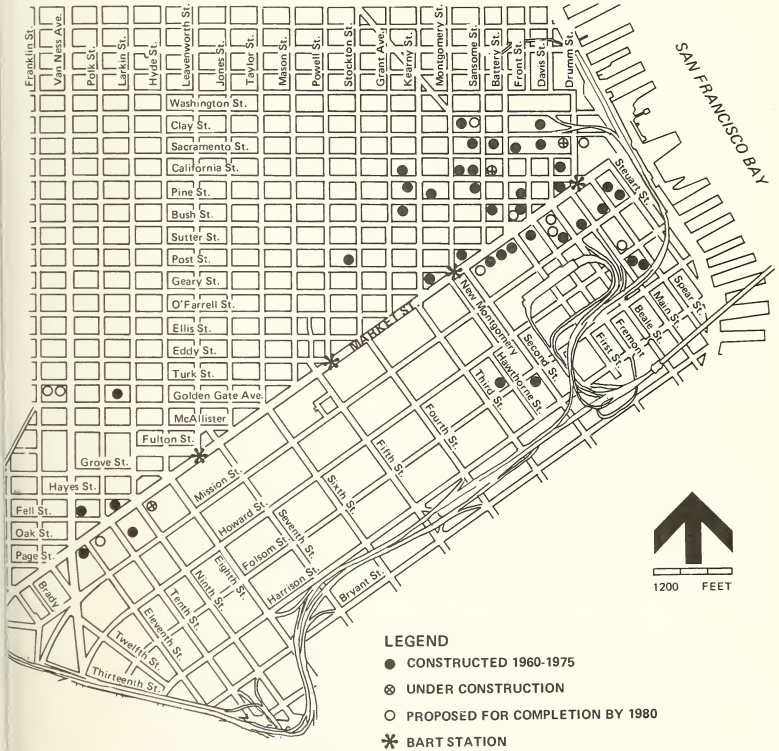
Development Project and the new zoning codes adopted by the city have been central to the redirection of the growth in office space. Factors not related to BART (the availability and low price of land in the Market Street area, constraints on growth in other directions, and access to other public transportation) are likely to have produced a similar growth pattern even without BART. However, BART has probably accelerated the redirection of the financial district's growth.

Downtown Oakland has experienced a much lower level of new office construction than has San Francisco. Approximately two million square feet of major new office space has been added since 1965. Roughly 1.5 million square feet were within 1,500 feet of a BART station, and BART was an important factor in the locaton decisions for 80% of this new space, both directly, because of its service, and indirectly, because of its role in expanding public projects such as the City Center Redevelopment Project.

Three other communities--Richmond, Berkeley and Walnut Creek--have experienced increased office construction near the BART station. The amount of new office space built in Richmond and in Berkeley has been small; one or two buildings dominate each city's total. However, most of that which has been built is located within the BART station areas. Office construction in Walnut Creek has been more substantial and has shifted considerably toward the BART station.(2) In the early 1960's about 5% of the community's new office construction occurred near the BART station, while by the mid-1970's about 30% occurred within one-third mile of the station.

BART has not affected the share of office space of the communities within its District. A substantial change in the location of new construction in the BART District as a whole has occurred since BART operations began, but this change is not attributable to BART. Between 1963-1965 and 1974-1976 the suburban share of new office construction within the BART counties increased from 6% to 14%. The share of the two central cities, San Francisco and Oakland, declined during the same period, from 90% to 83%. On an absolute basis, however, the two cities experienced 140% more construction in the mid-1970's than in the early 1960's, as measured by dollar value. The major reasons for the increasing growth of office construction in the outlying areas have been the increase in population, the lower cost of land in suburban areas as compared to that in central cities, and zoning provisions which have made the suburban areas attractive for new office development. No buildings were found to have been induced by BART to locate in the suburbs rather than in the central cities. Nor were any office buildings built in San Francisco which would have been located in another city without BART.

FIGURE 19
LOCATION OF MAJOR DOWNTOWN OFFICE BUILDINGS[1] CONSTRUCTED 1960-1975 AND PROPOSED FOR COMPLETION BY 1980 IN SAN FRANCISCO



[1] Buildings or portions of buildings with a height of at least 10 stories or 118 feet.

Source: San Francisco Department of City Planning

LOCATION DECISIONS FOR RETAIL STORES:BART has had little influence on the location decisions of retailers in the Bay Area to date, despite the fact that transportation service is generally an important consideration in the location decisions of merchants. Proximity to a BART station has been a consideration in the location of only two stores, one in Walnut Creek and one in Fremont. Retailers in San Francisco perceived bus access to their stores to be more important than a location near BART, while suburban retailers stressed the importance of automobile access. (The lack of established BART service on Saturdays when this survey was conducted may have influenced the responses of retailers.)

BART's impacts on retail sales within the communities it serves are not sufficiently pronounced, to date, to be clearly distinguishable from overall trends or from other factors. The results of interviews with merchants and shoppers suggest that the system may be influencing the shopping patterns of a small group of Bay Area residents, but sales tax data show no clear evidence. This indicates that any impacts which have occurred are too small to affect the community-wide sales tax receipts. Additionally, BART was not providing regular weekend service when the measurements were made. BART may have a measurable effect on retail sales when Saturday service has been provided for a sufficient length of time to permit new travel and shopping patterns to develop.

Among the thirty-five merchants and others knowledgeable about retail sales activities who were interviewed, 18% felt that proximity to BART stations had enhanced sales; the remaining 82% felt BART had had no effect. About half the merchants interviewed, however, mention BART in their advertising.

Shoppers were interviewed in six shopping areas served by BART. The results indicate that BART has influenced the shopping location decisions of some persons patronizing stores in these areas. A total of 499 shoppers were interviewed; of these, 177 were persons who had begun to patronize the areas during the period of BART's operations. In all six locations these new shoppers showed a significantly higher propensity to use BART than did those who had used the areas for a longer time. Moreover, the new shoppers frequently cited BART as the reason for their shopping in the area. (The survey, made in 1977, queried persons shopping on weekdays only. BART Saturday service had begun too recently to permit stable patterns to develop.)

The BART influence was most pronounced in San Francisco and Walnut Creek, where over 40% of the new shoppers surveyed reported that BART was the reason they had begun to use the area. Because the survey was designed to include a larger proportion of BART riders than a random survey would represent (one-half the respondents were BART riders), the BART influence is probably overstated. However, it is clear that BART has had a significant effect on the shopping location decisions of some BART patrons. This suggests that the system's influence is likely to continue and to grow when service is improved, and when the effects of BART Saturday service begin to be apparent.

WORKERS' LOCATION DECISIONS

Workers in San Francisco and in East Bay communities served by BART who have recently changed jobs were surveyed to determine the extent to which BART has influenced their choice of jobs. (A total of 276 workers who had recently changed jobs was sampled.) The results indicate that job-related reasons--such as better pay, better benefits, or more interesting work--are the primary factors in the choice of a job.

Nevertheless, the desirability of any given job location is often a function of BART accessibility. One respondent in four reported seeking his or her job with the intention of commuting by BART. (Since half of the persons surveyed were BART riders, the degree of BART's influence is overstated in the results.)(3) BART's influence was strongest among San Francisco workers living in the East Bay; 57% cited BART as a factor in their choice of a job location. The responses of workers asked about the importance of a job location near BART is shown in Table 21.

TABLE 21

IMPORTANCE OF A JOB LOCATION NEAR BART

	Percent of Responses	
	BART Commuters	Others
Proximity to BART		
-Major consideration	31.3	7.6
-Minor consideration	32.1	16.6
Looked for work in areas with expectation of using BART	39.7	20.7
Looked for work in areas only because of BART	38.5*	36.7*
(Total Respondents)	(131)	(145)

Source: Ref. 49

*Subset of previous group, i.e., percent of those who looked for work in areas with expectation of using BART.

HOUSING CONSTRUCTION: BART has affected the housing industry to some extent, but thus far the impacts have not been those which BART planners expected. No Toronto-like nodes of high density development have appeared in station areas. Housing development related to BART has generally occurred beyond the immediate station areas. However, the construction of multi-family units has been at an all-time low in the Bay Area in recent years. Most areas around BART stations were developed prior to BART's construction, and the construction of houses on previously-developed land is generally not economically advantageous, particularly when vacant land is available at some distance from BART in a number of areas. For these reasons, the lack of large-scale private development near the stations is not surprising.

BART's impacts on residential construction were studied in nine areas. Four were older urban residential areas: the Mission District in San Francisco, Fruitvale and East Oakland in Oakland, and Richmond. In these areas there is a mixture of single-family and rental housing. However, no vacant land for residential development exists in these communities, and BART has not provided an incentive for more intensive residential development. Five were suburban areas: Daly City-Pacifica in San Mateo County near the terminus of the BART line through San Francisco; Walnut Creek, a community on the BART Concord line; the Pittsburg-Antioch area in Contra Costa County which is beyond the BART line but served by the BART express bus service; the Fremont-Union City area and the City of Hayward, served by the Fremont line. BART has improved transit travel times between all of these areas and downtown San Francisco. Characteristics of the land uses in these areas are shown in Table 22.

The number of residential units authorized, as a share of the total in the three-county residential communities, increased in only two of the areas in the period 1962-1977, as shown in Table 22. In these areas considerable land was available for development and market demand was good. Interviews with developers and apartment managers indicated that BART has influenced demand in the areas, but that it has not been a paramount factor in the growth. Two-thirds of the twenty-six developers interviewed characterized BART as a "somewhat important" factor in their decision-making. Half stated they would pay a premium for developable land near a BART station. In each of the other suburban communities studied the overall trend has been downward.

BART has, however, affected locational and timing decisions for at least six major projects representing 3,500 units, approximately 10% of the 1965-1978 volume of housing built in the BART corridors by the developers interviewed. The projects are located in Pittsburg, Walnut Creek and in the Fremont area. Two large projects in Walnut Creek, with a total of over 1,000 units, were built in anticipation of BART service. Two others, one in Walnut Creek and one in Pittsburg, have been built since 1976. Two are developments authorized for construction in 1978--both in the Fremont area.

TABLE 22

HOUSING CONSTRUCTION STUDY AREAS: RESIDENTIAL LAND USE AND DEVELOPMENT

STUDY AREA	1975 HOUSING DENSITY*	1975 DEVELOPABLE ACREAGE		1962-1977 AVERAGE ANNUAL CHANGE IN % SHARE OF RESIDENTIAL BUILDING PERMITS**
		No. OF ACRES	% OF TOTAL ACREAGE	
Daly City	14.5	160	2.4	
Pacifica	7.9	3843	28.7	
(Total)	(10.5)	(4003)	(20.1)	-0.1
Hayward	7.4	794	10.9	-0.1
Fremont	6.5	5818	9.6	
Union City	4.9	424	6.7	
(Total)	(6.2)	(6242)	(9.3)	0.4
Walnut Creek	7.4	2981	13.8	-0.1
Pittsburg-Antioch	6.7	5303	21.9	0.6

*Housing units per acre

**Share of permits authorized in Alameda, Contra Costa and San Mateo Counties (excluding Oakland)

Source: Association of Bay Area Governments (ABAG) Projections: 1977
Security Pacific Bank, "Construction Reports"; Ref. 47

Although BART has influenced developments in two areas previously considered beyond commuting distance to San Francisco--Fremont-Union City and Pittsburg-Antioch--it has not been an important factor in suburbanization. It is likely that development would have occurred in those areas eventually as a result of the scarcity of developable land near the central cities, the continued demand for single-family dwellings, and several major highway improvements.

BART has not had a marked effect on new housing construction in its station areas, despite its influence on a number of projects. Few projects have been built that could be considered within the station area (within 1,500 feet of a station) even though nine station areas have been specifically zoned for high or medium-density residential development. On the other hand, some communities have explicitly prohibited high density development.

One reason for a lack of impact in station areas is the fact that housing does not need to be close to BART to be influenced by it in auto-oriented suburban areas where BART provides parking lots. An analysis of a Household Location Survey, which is discussed below, indicated no difference in the importance of BART in the location decision whether the respondent was within a ten-minute walk or a ten-minute drive of the station. When nearly every household has at least one automobile, rapid transit represents a marginal increase in accessibility and it can not, by itself, have the nucleating effects that it did when other means of transportation were scarce and people needed to live within walking distance of transit. The ratio of cars to employed household members in outlying areas is likely to be as high or higher for apartment dwellers as for occupants of single-family homes.

A number of other factors work against high density residential development in BART station vicinities: (1) local opposition to high density development is precluding such development along the Concord line from Orinda outward; (2) a sufficient market may not exist for high density residential projects in suburban locations currently zoned for such development, because of the prevailing preference for single-family dwellings; and (3) outlying station areas themselves are not always attractive for residential development either because of the ambiance created by the large BART parking lots and related traffic congestion or because the stations are in declining areas. In addition, the amount of time since BART began operations may not be sufficient to have generated substantial impacts on housing development.

Residential development along a small portion of the BART trackway has been influenced by BART-generated noise. BART-generated sound exceeds community noise levels in a narrow strip of land adjoining about seven miles of the BART trackway. All but two of the seven miles are fully developed. However, there is evidence that developers have been reluctant to become involved with properties in the two-mile undeveloped stretch, which is in Union City and Fremont. These two cities have grown at a rate that would cause pressure for residential development, but no residential development has occurred along the two miles adjacent to BART. Representatives of four developers interviewed confirmed that their development decisions had been influenced by the potential noise impacts of BART. Most of them knew of property owners in the locality who had had problems selling their land because of BART-generated noise.

Problems arising from BART-generated noise have a number of facets. For instance, the Federal Housing Administration (FHA) resists insuring home loans in noise-impacted areas. Also, builders are faced with a myriad of State of California regulations in noise-impacted areas, and since 1972 the state has required cities and counties to adopt a noise element as part of their general plans. Compliance with the regulations can be costly. The costs may include fees paid to noise consultants, costs incurred during delays for project reviews, the cost of installing noise insulation, or total write-offs if the projects are not approved.

RESIDENTS' LOCATION DECISIONS: BART has had virtually no influence on Bay Area residents' initial decisions to move, and it has not stimulated moves out of older, urban-residential areas, according to a survey of

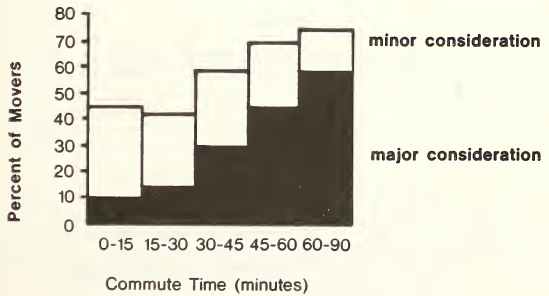
over 300 recent movers.(4) However, BART is becoming a common factor in decisions about where to move. Half of the survey respondents considered access to BART in their selection of a place to live. Compared to other factors in the decision, BART proximity is relatively minor. It typically ranks sixth to tenth behind considerations such as housing type, general access to workplaces and neighborhood characteristics. Nevertheless, one in five of the movers surveyed expressed a willingness to pay more for a location near BART.

BART's importance in the residential location decision increases with commute time; long distance commuters most frequently consider BART in their housing decisions. As a corollary, BART has had a greater effect on moves to suburban locations than to urban locations. Therefore, individuals in middle and upper income brackets more frequently considered BART in their location decisions than did low income movers.

BART riders who were interviewed considered access to a BART station in their residential location decisions more frequently than those who were not BART riders. A more surprising result of the survey was that 40% of the auto and bus commuters sought access to BART in choosing a new neighborhood in which to live. For these commuters, BART may represent a means of keeping their transportation options open and protecting their investment in a home should traffic congestion reach intolerable levels or gasoline shortages curtail automobile use. This interpretation is supported by the finding that homeowners were more inclined to seek a near-BART location than were renters. Purchasers of a home are more likely to adopt a long-term perspective in their residential selections.

FIGURE 20

BART'S IMPORTANCE IN RESIDENTIAL LOCATION CHOICES AS A FUNCTION OF COMMUTE TIMES



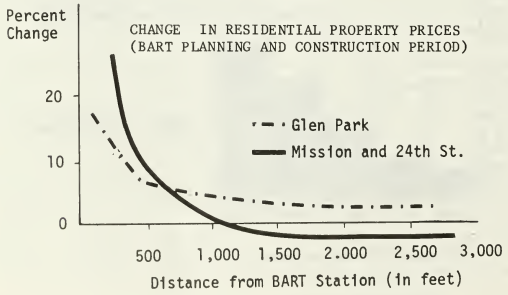
SOURCE: Ref.53

BART was planned and built during a period of economic expansion and growth. The combination of a high level of economic activity and optimism in regard to BART's potential effects resulted in the construction of some commercial and residential developments and in price increases for some properties near proposed locations for BART stations. The opening of BART coincided with the recession of 1973-1974. This downward turn in the economy, combined with delays in the provision of the full extent and quality of BART services, is reflected in diminished impacts on property prices and new developments since BART service began.

The impacts on residential property prices and on residential and office rents were studied in ten station areas representing the downtown areas of major cities, residential neighborhoods in the cities, and suburban communities. The areas differ in terms of development type, price, and in the mixture of commercial and residential uses. For example, Walnut Creek is a relatively new, higher-priced residential suburb with commercial development concentrated near the BART station, while the Glen Park and El Cerrito Plaza Stations are located in older residential areas with varying amounts of strip commercial development. The residential areas of the Mission District in San Francisco are liberally mixed with both commercial and industrial uses. Station areas in downtown Oakland and San Francisco are entirely in commmercial use with a wide range of rents and prices.

RESIDENTIAL PROPERTY PRICES AND RENTS: Residential property prices were analyzed in six station areas (El Cerrito Plaza, Glen Park, Mission 16th & Mission 24th, South Hayward and Walnut Creek). Clear indications of a BART influence on increases in property prices in the planning and construction period were found in four areas; Glen Park, Mission 24th St., Walnut Creek and South Hayward. The BART effect could be distinguished from other variables most clearly for the period of the early 1960's to the beginning of operations for the Glen Park and Mission 24th St. Stations, as illustrated in Figure 21.

FIGURE 21



Source: Ref. 56

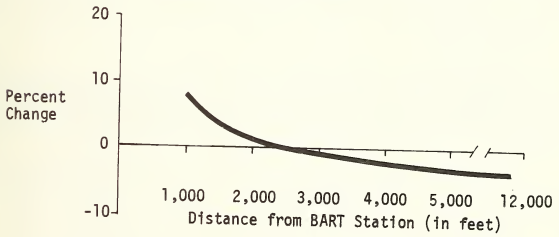
As the figure illustrates, BART's influence on price increases was most pronounced for homes within 500 feet of a station, and diminished rapidly with increasing distance. In no case did it extend beyond 5,000 feet of a station.

In the area of the Mission 16th St. Station a large variation in property prices has occurred. However, it resulted from a variety of influences and the specific BART influence could not be determined. BART had no apparent effect in the El Cerrito Plaza area where the station is adjacent to a shopping center.

BART has had a positive impact on prices in the South Hayward area from the period of station construction to the present. (Data for the planning period are not available for this area.) At 1,000 feet from the station BART has caused property price increases of about 8%, as illustrated in Figure 22.

FIGURE 22

CHANGE IN RESIDENTIAL PROPERTY PRICES IN THE SOUTH HAYWARD AREA
(BART CONSTRUCTION AND OPERATIONS PERIOD)



Source: Ref. 56

Property price increases related to BART affected entire communities in two cases. In Glen Park, an older residential neighborhood in San Francisco, transit service had been poor prior to BART's opening. After BART operations began property prices rose 5% more than in the surrounding areas. Key informants attribute this increase to BART's improvement of transit access.

BART's service may have played a role in the city-wide property price increases which have occurred in Walnut Creek. However, BART is associated with declining prices for homes near the Walnut Creek Station, where parking and traffic problems have occurred. This demonstrates the importance of careful planning for access and parking at rail transit

stations in residential areas, if the station is intended to enhance the attractiveness of the area.

In the other communities studied, the positive effect of BART on property prices diminished once operations began. It is likely that perceptions of the advantage of locations near the stations changed when BART service proved to be less extensive than anticipated, and when the reality of the generally minor increases in accessibility provided by the system became apparent.

Residential rents are less likely than property prices to be sensitive to anticipations of long-term benefits from planned transit services. Rather, they respond to existing, functional conditions. For this reason changes in rents were studied only for the period of BART's operations. Studies of changes of rents were conducted in two locations, the Mission District of San Francisco and Walnut Creek. No BART-related changes were found in the Mission District. In Walnut Creek proximity to the BART station is apparently becoming a positive influence on rents, while location near the BART trackway is having a slight, but smaller, negative effect. However, the evidence for these changes is slight, at present, and the conclusion cannot be asserted with confidence. In Walnut Creek as a whole, residential rents have increased more than elsewhere in the Bay Area; this increase may be due, in part, to the improved transit service BART provides.

COMMERCIAL PROPERTY PRICES AND RENTS: Office rents were found to be more consistently affected by BART than the rents or prices of residential properties, probably because work locations are generally more sensitive to mass transit access than the more auto-oriented residential communities.

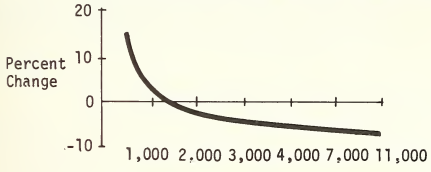
Office rents in downtown Oakland, San Francisco and Walnut Creek were studied. Rents in all of these areas have increased in absolute value since the start of BART service, but they have decreased in relation to rapidly-escalating costs of office construction in all but one of the areas (Walnut Creek). A rent index was defined as the ratio of rents to construction costs, and percentage changes in this index were used as the measure of BART's effects on office rents.

A location near a BART station is associated with increases in rents in all three areas studied. The magnitude of the increase has been greatest in downtown Oakland. However, the impact there has been limited to offices in the upper range of rental prices, even within the same building; this suggests the possibility that BART has affected only the more prestigious new office spaces in the newer office buildings in Oakland. However, no explanation for this effect has been found. Average rents for all offices in downtown Oakland have decreased by 14% in comparison to office building costs since 1972 when BART operations began. For offices in the upper range of rents which are very close to a BART station (less than 200 feet), office rents have increased over building construction costs an estimated 6% to 14%. The positive impact diminishes with increasing distance from a station, but for offices closer than 1,000 feet to the stations in Oakland, the impact on rents in the upper portions of the rental range was sufficient to offset the

general decline in the ratio of rents to construction costs. (Most of the buildings in the sample which are near a BART station are in the new City Center Project; therefore, the impacts on office rents may be joint effects of proximity to BART and the City Center Project.) BART's impacts on office rents in downtown Oakland are illustrated in Figure 23.

FIGURE 23

CHANGE IN OFFICE RENTS IN DOWNTOWN OAKLAND
AS A FUNCTION OF DISTANCE TO A BART STATION

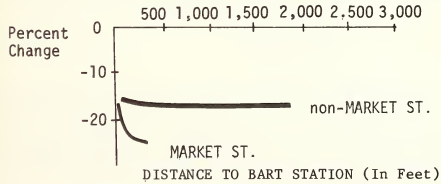


Source; Ref. 56

The magnitude of BART's impact on office rents has been smallest in downtown San Francisco. The average decline in office rents in comparison to building costs in the entire downtown San Francisco area has been 17% since BART service began. The impact of BART on rents for offices within 100 feet of the stations helped offset this decline by negligible amounts--1% to 2%--and it is undetectable for offices located more than 100 feet from a station, as illustrated in Figure 24.

FIGURE 24

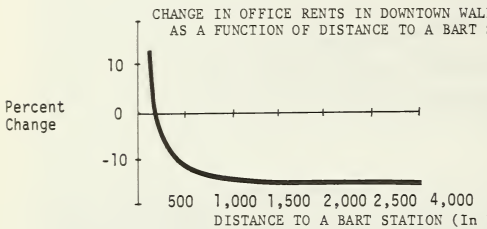
CHANGE IN OFFICE RENTS IN DOWNTOWN SAN FRANCISCO
AS A FUNCTION OF DISTANCE TO A BART STATION



Source: Ref. 56

In suburban Walnut Creek all office rents have increased by nearly 2%, on the average, in comparison to office construction costs since BART service began. This is in sharp contrast to the general decline in the ratio of office rents to office construction costs in San Francisco and Oakland. Whether the increase can be attributed to BART or to the economic growth which has occurred in central Contra Costa County, or to both, could not be determined by this analysis. The analysis indicated that the joint impact of building height and proximity to BART for offices within 600 feet of a BART station was an increase in rents over building costs of 9% to 15%. The increase diminished rapidly with increasing distance from the station: rents showed a decrease in relation to building costs at distances of 2,000 feet or more from the station.

FIGURE 25



Source: Ref. 56

Only one area, the Mission District, yielded sufficient data for an analysis of changes in commercial property prices. The evidence, which includes key informants' opinions, indicates that BART had some positive impacts on commercial property prices in the area. The effect is estimated to be slightly over 1% at a distance of 500 feet from a station. BART's influence occurred when anticipations about the system's impacts were high, prior to the beginning of service. It has since disappeared.

SPECULATION

Speculation, as defined in this section, is the buying and/or holding of real property in expectation of profit from changes in the market price which results from BART. This definition excludes investments for several purposes, only one of which is speculative. In other words, for purposes of this analysis, the motivation behind the purchase or holding of the property must be purely speculative.

BART's impacts on speculation were studied by analyzing data on property turnover, owner occupancy, zoning variance requests, and use conversions. In addition, forty-one interviews were conducted with real estate specialists and city and county planning officials.

The results indicate that speculation related to BART has not been an important phenomenon in BART station areas. Although it occurred in thirteen of the seventeen station areas studied, in no instance did it involve large-scale purchase or holding of land. Rather, it centered on small commercial and residential properties.

Nowhere has the speculative activity caused noticeable impacts on land use such as intermittent land uses or vacant lots. Most of the speculation occurred in the 1960's during the period of station construction when expectations about BART were at their highest. Soon thereafter the activities declined and eventually vanished in all locations except Richmond, where some speculation may still be occurring. Indications are that anticipated profits have not yet been realized from BART-related speculation.

The level and type of speculation varied considerably from community to community. For example, downtown San Francisco experienced no speculative activity, while in downtown Oakland speculation occurred in both commercial land and office buildings. The most likely reason for the absence of speculation in downtown San Francisco is that long-term investors have outbid speculators for available property.

EXPECTATIONS FOR THE FUTURE

Several factors may tend to increase BART's land use impacts in the future. Improvements in train frequencies and reliability will increase BART's attractiveness as a travel mode. This, in turn, will affect the location decisions of residents, workers, shoppers, and businesses. Both corridor and station area demand for housing and commercial structures will be affected. In addition, the current low level of multi-family construction will not be permanent in view of growing housing demand, diminishing supplies of buildable land in the BART service area, and the soaring prices of single-family homes. As the demand for multi-family housing increases, developers may favor BART station-area sites because of a demand for BART-oriented housing and because zoning policies encourage higher density housing developments in some communities.

A third factor potentially affecting BART's influence is increasing congestion and delays on competing modes. As highways approach or exceed their capacities BART's travel-time advantages will increase.

BART's current influence on the location decisions of residents, workers and shoppers suggests that even at present patronage levels the system will have a long-term effect on urbanization patterns. Over time this will make BART-served corridors more attractive for development than areas without BART service.

However, even with increases in patronage BART's land use impacts are not likely to be as dramatic as originally expected because opportunities for change are limited and because many factors unrelated to BART are critically important to land use changes. The most visible effects are likely to occur around downtown stations and station areas with vacant developable land. Where BART station areas are already developed it is not likely that the system will cause redevelopment unless other conditions, such as strong market demand and supportive land use policies and zoning regulations, are present.

FOOTNOTES TO CHAPTER 6

(1) To determine whether and to what extent BART has influenced the decisions of developers of new office space, persons knowledgeable about office construction decisions were interviewed. They included developers, realtors, bankers, city officials, investors, major employers and community leaders. In addition, building permit data were used to determine changes in office construction within each city and station area. The station area was defined as the area within one-third mile of a BART station except in downtown San Francisco (where it was two blocks) and in Fremont (where it was 0.6 mile).

(2) Ten million dollars were spent for new office construction in Walnut Creek from 1974 to 1976, compared with $848,000 in Richmond and $1,054,000 in Berkeley.

(3) Conducted by Tyler Research Associates, for the Land Use and Urban Development Project (1977). (Ref. 49)

(4) Household Location Survey, 1977. (Ref. 53)

CHAPTER 7

THE ECONOMIC AND FINANCIAL IMPACTS OF EXPENDITURES FOR BART

SUMMARY

Expenditures for building and operating BART have not resulted in major, long-term economic benefits or burdens in the Bay Area. The economy in the region is varied and the region's resources are generally well utilized. Therefore, while BART construction and operations have resulted in a large public debt and a large yearly expenditure of funds, they have not resulted in a marked stimulation or depression of employment, income and sales. The effects of inflation have resulted in a smaller relative tax burden for debt service on BART bonds than originally anticipated. However, the inflationary effects, together with BART's equipment problems, have resulted in an increasing level of operating expenditures. BART farebox revenues cover about 36% of operating costs, a ratio similar to that for bus operators in the Bay Area.

The BART operating costs, at the 1976 interim level of services, are greater than those of other transit operators in terms of costs for each trip carried, but they are approximately equal in terms of costs per passenger mile of travel. This is because the average length of a trip made on BART is appreciably greater than the typical trip made on other transit systems. BART operating costs per passenger and per passenger mile are expected to decrease in the future, in terms of constant dollars, as ridership increases.

The $1.2 billion spent in the Bay Area for BART's construction over a thirteen-year period generated total sales and income of $3.1 billion. The direct employment impacts of the construction of the system were 31,000 person-years of employment; the total direct, indirect and induced impacts raised the employment impact to over 75,000 person-years. These large impacts represented only a small proportion--less than one-half of one percent--of total regional employment and of the gross regional product in any single year of the construction period.

Although the size of the general obligation bond issue which financed a large portion of the local share of BART's construction cost was unprecedented, it had no discernible effect on the cost of borrowing for other public projects in the Bay Area, on the willingness of local governments to borrow for other public projects, or on voters' responses to other bond issues. (This finding may not be applicable to other urban areas at the present time, in view of New York City's and other cities' problems with debt payments.)

The impact of BART's expenditures for operations on retail sales and income in the Bay Area in 1976 is estimated to have been $149 million. Total personal income increased $51.9 million as a result of BART's operating expenditures in 1976, and 22% of this total went to minority households. Again, in the context of economic activity in the Bay Area as a whole, these impacts are relatively minor.

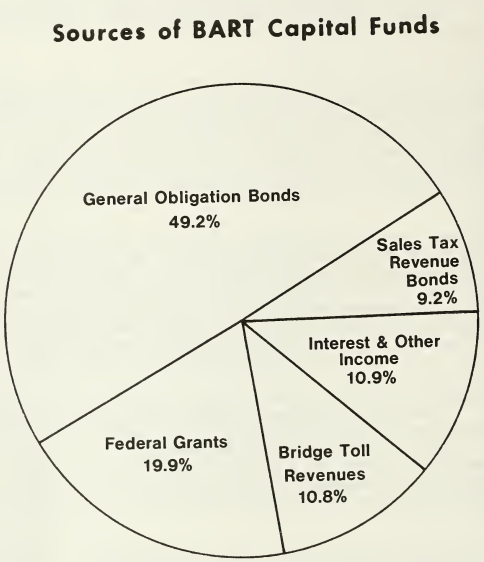
Households pay a majority of BART's locally-funded capital cost and its operating deficit. The total property and sales taxes paid by a low-income family of four with a poverty-level living standard in 1976

was $21, or 0.88% of the total hosehold income of $2,362. An affluent family of four paid a total of $153, or 0.33% of their income. The pattern of proportionate tax burden which increases with decreasing incomes is typical of the incidence of taxes used to fund most urban services. The property taxes imposed for debt service on the general obligation bonds have been a very small percentage of the overall composite local tax rates (3-4% in most cities in the BART District), and the BART share of the composite tax rate has decreased each year since the mid-1960's because of the growth of the tax base.

BART CAPITAL COSTS(1)

Funding for BART was authorized by the voters in its three-county District in 1962, before federal funds for urban transit projects were available. As a result, 80% of the system's total ($1.636 billion) capital cost is locally funded. The BART District has received $325 million in federal funds to help build the system since federal grants became available in the mid-1960's. Sources of the capital funds are shown in Figure 26.

FIGURE 26



Source: BART District Records

COMPARISONS OF ACTUAL AND ANTICIPATED CAPITAL COSTS: Original capital cost estimates for BART were published in the May 1962 BART "Composite Report." Table 23 compares the 1962 estimate of $994 million to the current forecast of $1,636 million for final actual capital costs. Virtually all of the increase is attributable to changes in scope from the originally planned system, to higher-than-anticipated inflation, and to inflation costs resulting from delays to the construction schedule.

Changes in scope account for about 32% of the cost increase. (See Table 23, column 4.) The scope changes provided additions and improvements to the planned system such as the Embarcadero Station, elevators and other facilities for disabled persons, and the undergrounding of the line and stations in Berkeley. The total increase in costs attributable to scope changes (including costs attributable to inflation and the delays associated with scope changes but excluding the allowance for contingencies) is $205 million.

Higher-than-anticipated rates of inflation account for about 17% of the cost overrun. The Composite Report allowance for inflation, based on a review of historical inflation rates prior to 1960, was a constant rate of about 3% per year. This rate was included in estimates for the construction period which was anticipated to extend through 1967. In fact, inflation rates since 1962 have been considerably higher than 3%, averaging almost 8% per year over the period 1964-1973 when the major part of BART construction took place. Based on the Engineering News Record (ENR) Building Construction Index for San Francisco, the accelerated inflation rates alone would have resulted in an increase of $106 million for the construction of the original BART system planned in 1962. (This estimate excludes delays in the construction schedule and changes to the originally planned scope of the project.)

Inflation due to delays in the construction schedule account for $362 million, or about 56% of the cost overrun. BART's planners originally estimated that it would take about six years to build the system. It actually took nearly eleven years. Lengthy delays were caused by a number of events:

- A court suit challenging the 1962 election delayed the entire project by about ten months.
- Negotiations with cities concerning BART routing, design features, and station plans were more extensive than anticipated and caused additional delays.
- A shortage of funds plagued the project between 1967 and 1969 and necessitated lengthy delays while additional funds were sought.

TABLE 23

ESTIMATED and ACTUAL
BART SYSTEM CAPITAL COSTS
(All Costs in Thousands of Dollars)

	Composite Report Estimate, 1962	Actual Expenditure to 1980	Increase (Decrease) Amount	Percent of Total	Adjusted Amount*	Adjusted Percent of Total
Basic System and Transit Vehicles	$750,506	$ 792,884	$ 42,378	7%	$ 42,378	7%
Composite Report Contingency Allowance	74,352	--	(74,352)	(12)	--	--
Inflation Presuming no Delays	169,555	275,687	106,132	17	94,861	15
Inflation due to Delays	--	362,307	362,307	56	321,755	50
Changes in Scope	--	204,722	204,722	32	182,193	28
Total	$994,413	$1,635,600	$641,187	100%	$641,187	100%

* Contingency allowance of $74,352,000 distributed among "inflation presuming no delays," "inflation due to delays," "changes in scope" in proportion to amounts given in column 3 for these three cost categories.

The cost increase associated with changes in scope, inflation presuming no delays, and inflation due to delays totals $673 million. This compares with an allowance of only $74 million made for contingencies in the Composite Report. The difference, $598 million, accounts for 93% of the total $641 million overrun.

Only the remaining 7% ($43 million) could not be assigned to a definite category by this analysis and was classified as "unexplained." Presumably, this amount reflects shortcomings of the original Composite Report cost estimates, but it may also include scope changes not identified in the analysis. Given these uncertainties, the $43 million "unexplained" component of the total cost overrun can be regarded as relatively small in the context of the overall $1.636 billion BART project, and it reflects favorably on the accuracy of the original engineering estimates. If the Composite Report contingency allowance is distributed among the cost categories of "inflation presuming no delays," "inflation due to delays," and "changes in scope" in proportion to the amounts shown in the third column of Table 23, an adjusted percentage distribution is obtained. This is given in the final column:

- 50% ($321 million) is explained by the costs of inflation associated with delays).
- 28% ($182 million) is explained by scope changes.
- 15% ($95 million) is explained by the effects of higher-than-anticipated inflation.
- 7% is due to other, unexplained factors.

ECONOMIC AND FINANCIAL IMPACTS OF THE BART CAPITAL EXPENDITURES

The impacts of BART capital expenditures on regional economic activity were evaluated through the use of input-output analysis. That is, the volume of economic activity generated in the nine-county region by each dollar spent for transit construction was measured. In addition, all the secondary or indirect impacts of the expenditures on sales and income were calculated. This calculation included the purchases made by households with the income earned from direct or indirect expenditures for BART. The results of this analysis, which demonstrate the interaction among fifty economic sectors and two income categories, are shown in Table 24.

A total of $1.524 billion of BART capital expenditures was used in measuring the impacts. This figure does not include current expenditures for capital equipment which might be considered replacement equipment. These additional expenditures, which bring the total forecast cost to $1.636 billion, are for further vehicle testing and retrofitting, further work on train control and power distribution systems, additional parking facilities, and other similar projects. The capital cost associated with the No-BART-Alternative (NBA) would have been the cost of a small number of buses, all of which would have been built outside the region. (See Appendix B.) Their purchase would not have stimulated the Bay Area's economy. Therefore, the total amount spent in the Bay Area to build BART has been considered a BART impact; that is, an expenditure for transit which would not have occurred in the absence of BART. (As noted previously, the NBA transportation system would not have provided the capacity of the with-BART system.) The amount spent for goods and services within the Bay Area totals $1.199 billion, or 79% of the $1.524 billion of expenditures. The remaining 21% was spent outside the region.

The first column of Table 24 shows the direct impacts of expenditures within the region for goods and services. The second column shows the indirect and induced impacts. Indirect impacts are intermediate transactions, expenditures by suppliers for items such as raw materials. Each of the intermediate expenditures may require further purchases of goods and services. Induced expenditures are purchases made by households with income earned from the direct and indirect expenditures.

IMPACTS ON REGIONAL SALES AND INCOME

The $1.2 billion spent in the Bay Area for BART's capital costs over a thirteen-year period generated total sales and income of $3.1 billion (see column 2 of Table 24). This large impact, however, was only a small portion of the total regional economic activity during the construction period. The impacts did not exceed one-half of one percent of the gross regional product per year, when averaged over the thirteen-year period. The direct expenditure impacts were largely in the areas of construction, metals, maintenance, business equipment, and services. A large proportion of the indirect impacts was experienced in sectors such as retail trade, motor vehicle sales, amusements, and medical services.

TABLE 24

REGIONAL OUTPUT EFFECTS FROM BART CONSTRUCTION
1964-1976
(In Millions of 1976 Dollars)

S. F. Bay Area Input-Output Sectors	Direct	Total: Direct and Indirect
New Building Construction	$ 153.410	$ 153.410
New Highway Construction	116.510	116.510
New Construction - All Other	466.790	466.790
Food Processing	---	71.817
Petroleum Refining	0.020	35.825
Stone and Clay Products	6.690	53.258
Primary Non-Ferrous Metals	8.980	12.691
Fabricated Metal Products	29.170	63.088
Office and Computing Machinery	9.080	11.808
Motor Vehicles and Equipment	0.130	27.762
Transportation and Warehousing	0.980	61.828
Electric and Gas Utilities	---	30.620
Wholesale and Retail Trade	---	165.590
Finance and Insurance	0.943	62.378
Real Estate and Rental	8.221	92.021
Personal Services	---	25.021
Business Services	3.460	79.026
Automobile Repair and Amusement	---	45.162
Medical and Non-Profit Service	---	54.195
Public Transit Facilities	---	1.254
*Minority Income	0.347	115.598
*Non-Minority Income	1.304	811.200
**Landscaping Services	4.380	4.380
**Station Construction	47.250	47.250
**Service Facilities Construction	4.900	4.900
**Office Building Construction	4.790	4.790
**Rail Construction	70.820	70.820
**BART Operations	5.240	5.240
**Transit System Maintenance and Repair	2.770	2.770
**Professional and Administrative Services	195.950	195.950
**Utilities Maintenance and Repair	18.600	18.600
**Light Rail Transit Construction	1.310	1.310
***Other	37.897	227.090
TOTAL	$1199.942	$3139.952

*Miscellaneous BART salaries not shown elsewhere.
**Detailed construction elements not included in public transit facilities sector.
***Sum of 30 minor sectors. Details are shown in Ref. 64.

The direct employment impacts of the construction of BART were equivalent to over 31,000 person-years of employment. The indirect effects of direct, indirect, and induced expenditures raised the total regional employment impact to over 75,000 person-years. It is unlikely that any other single project in the Bay Area's history has had an impact of this magnitude on employment. However, when averaged over the thirteen-year period when the war in Vietnam contributed to high levels of employment in the Bay Area, BART's employment impact never exceeded one-half of one percent of total regional employment in any year.

Total construction employment within the nine-county Bay Area ranged between 80,000 and 91,000 a year between 1963 and 1973. When the BART construction employment was at its highest level, early in 1968, about 5,000 construction workers were directly employed. A project using this large a proportion of the construction work force might be expected to have an inflationary impact on construction wage rates. Bay Area construction wages did rise 40% during the years in which major BART construction occurred; however, the increase was consistent with long-term, nation-wide trends. It does not appear attributable to BART construction expenditures in particular. The increases that occurred over the period of major construction for BART correspond to increases in construction wages nationally, as they did in the years preceding and following BART's construction. National and long-range factors, rather than shifts in the market for construction labor, appear to explain the increases in Bay Area construction wage rates during BART construction. These results from a statistical analysis were supported by the opinions of construction leaders who were interviewed in the course of this study. The consensus was that BART construction employment had little impact on wage rates in the building trades in the Bay Area.

THE IMPACT ON MINORITY EMPLOYMENT OPPORTUNITY: A current objective for any major public works project is that of increasing minority employment opportunity within the work force. When BART was being built equal opportunity guidelines differed from current affirmative action requirements in their emphasis on eliminating employment discrimination against minority persons, rather than positively promoting the hiring of minorities. Compliance was not well enforced, and monitoring was sporadic. BART contractors were required to hire their workers through union hiring halls, and they were forbidden by equal opportunity regulations to request workers on the basis of racial, ethnic, or religious backgrounds. Therefore, the BART impact on employment for minorities cannot be directly related to the potential impact of similar current public works projects. The opportunities for impacts were fewer, and current affirmative action goals were not in force in the 1960's.

Minorities made up about 36% of the BART construction work force. Minority persons made up 22% of the total construction work force in the five-county Standard Metropolitan Statistical Area (SMSA) which includes the three-county BART District plus Marin and San Mateo Counties. (This area has been chosen for a measurement of BART's employment effects rather than the nine-county area because potential minority employees for

a heavy construction project such as BART construction are more heavily concentrated in the SMSA.) About 68% of the minorities employed were unskilled laborers. They were less well represented in the skilled laborer category. The major long-term benefit of BART's employment of minorities was that of introducing the concept of equal opportunity employment to contractors in the area. This conclusion is supported by the judgements of representatives of the construction contractors, the trade union council, the contract compliance agency, and BART, who were interviewed.

IMPACTS ON HOUSEHOLD INCOMES

Household income in the nine-county region increased an estimated $927 million due to the direct, indirect and induced expenditures for BART's construction. This represents less than one-half of one percent of the total estimated personal income in the region during the thirteen-year period, 1964 through 1976. Approximately 12.5% of the impact on household incomes accrued to minority households.(3)

THE IMPACTS OF BART'S BOND ISSUE ON LOCAL AND REGIONAL PUBLIC FINANCING

The size of the general obligation bond issue which financed the costs of constructing BART's basic system was unprecedented. In 1962 it was the largest single local bond issue in the history of the United States. The debt represented a full 15% of the assessed valuation of the property in the three BART counties, the legal limit for the debt of a special district. It doubled the indebtedness of the three counties. By 1969 the BART obligations averaged 40% of the general obligation debt in Alameda County, 45% in Contra Costa County, and 75% in the City and County of San Francisco.

The magnitude of the BART bond issue had the potential for changing the financial condition of the three counties and of local jurisdictions within the counties. For instance, the BART debt could have increased the cost of borrowing for other public projects if it had appeared to increase the risk of tax delinquencies. This did not occur. On the contrary, the major bond rating agencies rapidly upgraded the ratings of bonds issued by suburban areas within the counties during the construction period. There was no perceptible increase in the cost of borrowing in any of the three counties, and the BART debt has had no discernible impact on the financial condition of the cities within the BART District.

An additional possible impact of the BART bond issues could have been a refusal by the voters to endorse additional bonded indebtedness. This, also, did not occur. No failure of a bond issue or deferral of a vote on a bond issue has been attributed to BART. The non-voted bonds which have been used for many capital improvement projects in California since 1966 are unrelated to BART costs. The recent trend to increased use of non-profit corporation bonds, which do not require a vote, for capital

improvements is statewide, not a Bay Area development. It has no relationship to BART.

Neither has the BART tax rate for the general obligation bond debt had a measurable impact on city or county tax rate decisions. This is primarily due to two circumstances: (1) the taxes imposed for debt service on the general obligation bonds have been an insignificant percentage of the overall composite local tax rates; and (2) the BART share of the composite tax rate has decreased each year because of the growth of the tax base.

BART did have a financial impact on local capital improvements by providing local governments opportunities to utilize new funding approaches which would not have been available without BART. BART supplied financial assistance in the form of non-cash credits (and occasionally direct cash payments) to local communities where public improvement or redevelopment projects could be linked to rapid transit. Without BART's direct or indirect financial assistance local governments might have deferred construction on some capital projects, or modified them, or they might have funded them from other local sources.

In summary, the local share of BART's costs which is financed by general obligation indebtedness has had no negative effects on the cost of borrowing, on the willingness of local governments to borrow for other public projects, or on voter response to other bond issues. However, it is difficult to judge whether this result is transferable to other areas at the present time in view of New York City's and Cleveland's problems with debt payments. In addition, the passage of Proposition 13 in California has had reverberations nationwide. Several aspects of the results of this legislation, which has been in effect for a year in California, are relevant to the consideration of BART's impacts on public financing:

(a) BART's portion of local property taxes is exempt from the provision of Proposition 13 which limits property taxes to one percent of full assessed valuation. Conversely, it does not reduce the total taxable amount for non-exempt purposes.

(b) Local property tax revenues are expected to be reduced more than one-half. Therefore, the proportion allocated to the BART general obligation debt will more than double. In most parts of Alameda County, for example, this would mean a change from 3% of the tax bill to 7%.

DISTRIBUTION OF THE TAX BURDEN OF BART'S CAPITAL FINANCING

The total burden of BART's capital costs, considering the incidence of both property and sales taxes which have or will have funded BART's construction, is summarized in Table 25. The local cost of BART, including interest, will have been $1.7 billion by 1999. Sixty-five percent of this cost will have been borne by households through property taxes, rent increments reflecting the property tax, or consumer purchases of taxable retail items. Twenty-four percent will have been borne by

business, and almost 11% will be paid from sources outside the region. This includes taxes paid by tourists and businesses outside the region making purchases within the region. It also includes refunds to the counties for property tax exemptions through the state's Senior Citizen's Property Tax Assistance Program.

TABLE 25

THE INCIDENCE OF PROPERTY AND SALES TAXES FOR BART CAPITAL COSTS
(In Thousands of Current Dollars)*

	Property Tax	Sales Tax	Total	% of Total
Households	$ 982,989	$132,252	$1,115,241	65.0
Businesses	379,131	36,848	415,979	24.2
Export	168,163	18,800	186,963	10.9
Unallocated	- 1,529		- 1,529	- 0.1
TOTAL	$1,528,754	$188,000	$1,716,754	100.0

*Repayment of general obligation bonds 1964-1999. Repayment of sales tax revenue bonds, 1970-1976.

Source: Ref. 66

(This analysis was performed before Proposition 13, which alters the rate and distribution of property taxes in California, was approved by the voters.)

In determining this total burden, two assumptions were made. First, it was assumed that the relative proportion of land within each county dedicated to residential or business uses will remain constant between 1976 and 1999. Further, for the purposes of this analysis, the rate of inflation or appreciation of assessed value within each land use was assumed to be constant during the same period. Together, these assumptions limit the projection of property tax incidence to the characteristics of the region in 1976.

While households will have paid nearly 65% of the local cost of financing BART, local financing supported only 75% of the total system cost. Therefore, households actually paid less than half of the total cost of the system (as opposed to the local share). However, this represents a substantially higher local burden than other regions would experience today, when federal funding is available for up to 80% of the capital costs of new rail transit systems.

The impact of BART's capital financing on the income of a range of households representing different incomes, family sizes and consumption patterns is shown in Table 26. (Table 26 also shows the relative impact of taxes to cover operating costs. This is discussed in the following section of this chapter.) As the table indicates, the amount paid by

higher-income households is greater than that paid by lower-income households. However, the proportion of income paid for BART's capital costs is greatest for lower-income households. The household with the lowest income pays $15.63 per year, 0.66% of its income. The household with the highest income pays $111.31 per year, 0.24% of its income. Although public policy favors taxation methods which tax the affluent at higher rates than the less affluent, a method which is both workable and acceptable to the majority of taxpayers has yet to be devised. Taxation for BART's costs shares the regressive characteristics of local taxation for urban services such as schools and other forms of public transit.

The tax burden defined here should be recognized as a comparative measure, not an absolute one. Every household, depending on its housing and consumption patterns, will bear a different burden. (The statistical average of the total regional financing cost was $29.25 per capita in 1976.)

TABLE 26

TAXES PAID ANNUALLY BY TYPICAL HOUSEHOLDS FOR BART CAPITAL AND OPERATING EXPENSES

Income		Amount of Taxes Paid* Property Tax	Sales Tax	Total Payment	Taxes Paid as Percent of Income*
$2,362	Family of 4, poverty-level living standard, female head of household	$10.93 1.30	$ 4.70 3.95	$ 15.63 5.25	0.66 0.22
$4,489	Individual, lower living standard, over 65, retired	22.54 2.68	9.86 8.30	32.90 10.98	0.72 0.24
$6,851	Couple, low-moderate living standard, head over 65	24.18 2.87	14.09 11.86	38.27 14.73	0.56 0.21
$10,041	Individual, low-moderate living standard	15.98 1.90	15.97 13.44	31.95 15.34	0.32 0.15
$14,411	Family of 3, moderate living standard	34.14 4.06	16.44 13.83	50.58 17.89	0.35 0.12
$15,711	Couple, moderate living standard	35.38 4.20	21.13 17.79	56.51 21.99	0.36 0.14
$21,735	Family of 4, high living standard	40.99 4.86	29.12 24.50	70.11 29.36	0.32 0.13
$45,715	Family of 4, affluent living standard	71.86 8.53	39.45 33.20	111.31 41.73	0.24 0.09

*Upper line of numbers for each household represents taxes paid in 1976 for capital expenditures; lower line represents taxes for operating expenditures in fiscal year 1975-1976.

Source: Ref. 64

BART OPERATING COSTS AND REVENUES

A major expenditure associated with BART is the continuing expenditure for operations. A greater percentage of operating costs than capital costs must be met from local dollars under current federal funding policies, and they have a longer-term effect on the regional economy than the capital expenditures. BART operating costs have increased annually as the result of inflation and service expansions.

Net operating expenditures for BART were $55 million in the fiscal year ending June 30, 1976, and $68 million in the year ending June 30, 1977. The increase reflects the effects of inflation, the opening of Embarcadero Station, and preparations for service expansion. Table 27 shows gross and net costs for both years, distributed by three cost components: (1) operations; (2) maintenance; and (3) general administration.

TABLE 27

BART OPERATING EXPENDITURES(4)
(in thousands of dollars)

1. Fiscal Year 1975-76

Category	Gross	Capitalized*	Net	Percent of Net
Operations	15,222	38	15,184	27
Maintenance	28,047	651	27,395	50
General Administration	15,629	3,082	12,547	23
Total	58,898	3,771	55,126	100

2. Fiscal Year 1976-1977

Category	Gross	Capitalized*	Net	Percent
Operations	18,234	27	18,207	27
Maintenance	32,191	252	31,939	47
General Administration	20,877	3,175	17,701	26
Total	71,302	3,454	67,847	100

*Capitalized expenditures represent costs incurred for capital improvements which are reimbursed from capital funds, primarily from federal grants.

Source: BART Accounting Department

As shown in Table 28, BART passenger fare revenues (exclusive of discounts and other deductions) were $22 million in fiscal year 1975/76, and $25 million in fiscal year 1976/77. Fare revenues covered 36-39% of operating costs, a ratio which is similar to that of the two major bus system operators in the Bay Area.

TABLE 28

BART OPERATING REVENUES
1975/76 and 1976/77
(in thousands of dollars)

Category	1975/76		1976/77	
	Amount	Percent	Amount	Percent
Net Fare Revenues	21,714	35	24,692	35
Other Operating Revenues	1,507	2	1,466	2
Sales Tax Revenues	28,644	46	31,526	45
Property Tax Revenues	5,029	8	5,521	8
Federal Assistance	---		3,400	5
State & Local Assistance	1,686	3	384	-
Construction Funds & Other	3,771	6	3,454	5
Total	62,315	100	70,443	100

Source: BART Annual Report 1976/1977

In 1976/77 BART's operating cost per passenger trip was $1.93 and its cost per passenger mile was $0.15. Although the cost per trip is considerably higher than that for most other U.S. rail transit systems, the cost per passenger mile is similar. This reflects the fact that BART is a regional system serving a preponderance of long trips. BART operating costs per passenger and per passenger mile are expected to decline as ridership increases, in terms of constant dollar amounts. This will occur because the marginal cost of adding capacity to the BART system by increasing train frequencies or adding an additional route is relatively small. Current expenditures for administration, station operations, and for many maintenance functions will change very little as a result of operating additional trains, and they will be spread over a larger ridership base.

The operating costs shown in Table 27 do not include the unfunded depreciation of BART assets. The total depreciation allowance recorded in the BART Annual Report for 1975/76 was $26,122,000; for 1976/77 it was $26,211,000.

The economic impacts of BART operating expenses for fiscal year 1975/76 are analyzed in the next section.

ECONOMIC AND FINANCIAL IMPACTS OF THE BART OPERATING EXPENDITURES

The impacts of BART's operating expenditures were evaluated by input-output analyses similar to those used in evaluating the capital expenditure impacts. A total of $47 million of operating expenditures was used to measure the impacts. This amount represents the difference between the actual operating expenditures of the with-BART transit system in the Bay Area in 1976 ($169 million) and the operating expenditures estimated for the No-BART Alternative ($122 million).(5) This net impact has no cost-benefit implications. It simply estimates the net amount the BART counties paid for transit operations in 1976 in terms of the amount they would likely have paid for the alternative if BART had not been built. As noted earlier, the with-BART system was providing greater capacity and more service than the NBA would have.

IMPACTS ON REGIONAL SALES AND INCOME

BART's impact on the total sales and income in the region from operating expenditures alone is estimated to have been $149 million in 1976. This reflects the direct, indirect and induced sales and income generated to support BART operations. It results from the $47 million increase in transit operating costs over the hypothesized amount which would have been spent if BART had not been operating. The indirect sales and income include purchases of intermediate goods and services: for instance, a BART maintenance contract (which is a direct BART expenditure) may involve an intermediate purchase of labor, petroleum products, or tools, which are indirect expenditures. The impacts of purchases made by consumers with the income earned from direct or indirect expenditures are induced expenditures, which are also included in the total. All of the impacts represent only the sales and income impacts which are experienced inside the region. Table 29 indicates the economic sectors directly and indirectly affected by BART operating expenditures.(6)

The sectors directly affected by BART's operating expenditures include maintenance and repair, communications, electric utilities, finance and insurance and business services. Multiplied effects on transportation and warehousing, finance and insurance, real estate and government enterprises are indirect impacts of the operating expenditures. Sectors such as food processing, motor vehicles and wholesale and retail trade are affected as a result of increased consumer spending.

Total personal income in the region increased an estimated 51.9 million in 1976, due to the difference between BART's operating expenditures and those which would have been incurred by the NBA system. Almost 22% of this income went to minority households. This is considerably higher than the minority share of personal income generated by capital expenditures, reflecting the higher proportion of minority employees in the BART operating work force.

TABLE 29

REGIONAL OUTPUT EFFECTS FROM BART OPERATING EXPENDITURES
1976
(In Millions of Dollars)

S. F. Bay Area Input-Output Sectors	Total Direct and Indirect Impacts
Agriculture and Mining	$ 0.967
Maintenance and Repair Construction	2.453
Food Processing	4.486
Textile Products	0.628
Paper and Allied Products	0.459
Printing and Publishing	0.854
Chemicals and Plastic Products	0.879
Petroleum Refining	0.939
Metal Containers	0.287
Motor Vehicles and Equipment	1.858
Transportation and Warehousing	1.569
Communications	0.977
Electric and Gas Utilities	4.663
Wholesale and Retail Trade	7.882
Finance and Insurance	4.424
Real Estate and Rental	4.149
Personal Services	1.431
Business Services	3.076
Automobile Repair and Amusement	1.873
Medical and Non-Profit Service	3.722
Government Enterprises	1.142
*Net BART Operations	46.749
**Minority Income	11.198
**Non-Minority Income	40.663
***Other	1.650
TOTAL	$148.978

*BART operating expenditures less those of AC, MUNI, and Greyhound.
**Miscellaneous BART salaries not shown elsewhere.
***Sum of 29 minor sectors. Details are shown in Ref. 64.

The analysis for estimating BART's employment impact is similar to that used to calculate its operating cost impact. BART's staff in 1976 was about 1,865 persons. The BART impact on direct employment represents the difference between the employment requirements of BART and the NBA. On the basis of current experience, the NBA operators would require 600 employees more than they actually had in 1976. Thus, the net BART impact on direct employment is 1,265 employees. BART's regional employment impact from direct expenditures and the associated indirect and induced expenditures totals over 3,000 permanent jobs.

The direct employment per million dollars of operating expenditures by major transit agencies in the Bay Area is shown in Table 30. Rapid transit operations in the Bay Area generated fewer jobs in the region, per million dollars of operating expenditures than bus operations because bus operations are more labor-intensive. (The figures in Table 30 represent direct impacts; the indirect employment impacts of transit operations other than BART's have not been measured.)

TABLE 30

TRANSIT EMPLOYMENT PER MILLION DOLLARS OF OPERATING EXPENDITURE-1976

Transit Agency	Mode	Direct Employment Per Million Dollars of Operating Expenditure
BART	Heavy Rail	31.18
AC Transit	Bus	45.86
MUNI	Bus/Light Rail/Cable Car	48.31
Golden Gate Transit	Bus/Ferry	41.34

Source: Ref. 66

IMPACTS ON PERMANENT MINORITY EMPLOYMENT: To estimate BART's impact on employment opportunity for minorities and women, a comparison was made with the bus operators. The results are summarized in Table 31.

Minorities are a smaller proportion of total employees at BART than at the bus agencies, but minorities are generally employed in higher positions at BART. For instance, 20% of BART minority employees are classified as officials, administrators, or professionals, while only 6% of the minority employees at MUNI and AC Transit are in these categories. On the other hand, in the $25,000 and above annual salary category there are five times as many whites as minorities at BART, and only slightly over twice as many in the bus transit agencies.

TABLE 31

TRANSIT EMPLOYEES BY ETHNIC CATEGORY (1976)

	BART Employees		AC & MUNI Transit Agency Employees	
	Number	%	Number	%
White	1,115	60	2,738	51
Minority	750	40	2,631	49

Source: Ref. 66

BART minority employees are generally better paid, on the average, than AC Transit and MUNI employees, but this is true for the entire BART work force. It reflects the other agencies' employment of large numbers of bus drivers. At BART, by contrast, a large proportion of employees are skilled crafts workers.

BART has also employed women in relatively large numbers, and at relatively high income and job classifications. Nineteen percent of BART employees are female, and forty percent of them earn more than $16,000 annually. Although the preponderance of BART's women employees is in clerical positions, there are also significant numbers in the categories of professionals and skilled crafts. Other areas currently building rapid rail transit systems are likely to have similar or better minority and female employment profiles because of the equal opportunity guidelines which have been adopted in recent years.

The fact that equal opportunity policies became widespread while the BART work force was expanding is probably responsible for the degree to which minority and women employees at BART are working at all levels within the agency. It suggests that the introduction of a new transit system in a period in which affirmative action and equal employment opportunity goals are emphasized is an opportunity to provide jobs for minorities and women, and to upgrade their skills.

THE TAX BURDEN FOR BART OPERATIONS

The tax burden of financing BART operations has been evaluated on the basis of fiscal year 1976. The figures shown in Table 32 represent the cost of providing regional transit in the three-county District with BART, as opposed to the costs of the system assumed to exist without BART. They indicate the final incidence of the sales and property taxes which support BART operations.

Business bears the cost of nearly 21% of BART operations. The business share represents that part of the burden that has not been shifted forward to the consumer. Slightly more than 10% of the portion of the BART operating cost which is funded from local taxes is actually exported to taxpayers from outside the region, either as reimbursements from the State Treasury or as purchases by businesses or tourists who are not residents. Sixty-nine percent of the annual operating deficit is paid by households as homeowners, renters, or consumers.

TABLE 32

FINAL INCIDENCE OF BART'S OPERATING SUBSIDIES IN 1976

(In Thousands of Dollars)

	Property Tax		Sales Tax		Total	
Household	$3,790	63.9%	$14,798	70.4%	$18,588	69.0%
Business	1,471	24.8	4,121	19.6	5,591	20.7
Export	669	11.3	2,102	10.0	2,771	10.3
Total	$5,928	100.0%	$21,102	100.0%	$26,948	100.0%
% of total	22.0%		78.0%		100.0%	

Source: Ref. 66

The impact of BART financing on the income of a range of typical households -- with different incomes, family sizes and consumption patterns -- is shown in Table 26, on p. 145. The greatest relative burden of financing operating costs fell on the low income household represented by a retired individual who paid a total of $10.98 in FY 1975-76 to subsidize BART operations. This represents 0.24% of such a person's income. Similarly, a high relative burden was borne by a poverty-level family of four which paid $5.25 annually, or 0.22% of annual income. The affluent family of four which paid the highest absolute amount, $41.73 annually, had the lowest relative tax burden, of operating expenses, 0.09% of the total annual income. The regressive nature of BART financing for operations, as for construction costs, is a result of the nature of the local taxes which are used to finance BART.

FOOTNOTES TO CHAPTER 7

1. Capital costs described in this report include construction costs for the entire BART system including shops, yards, and the BART Administration Building; 450 BART transit cars; facilities for the new San Francisco Municipal Railway (MUNI) Metro light rail line; and pre-operational administrative and start-up costs. The BART system itself is seventy-one miles long, with thirty-four stations; the MUNI Metro line shares 1.7 miles of BART subway and four stations in downtown San Francisco. It also includes four miles of line and four stations beyond the BART line. It is estimated that the exclusive MUNI Metro segment cost approximately $70 million, and that MUNI's share of the joint BART/MUNI facilities is another $85 million. The total $155 million is about 10% of the overall BART capital costs.

2. The expenditure impacts on regional sales, income and employment have been measured in terms of the nine-county economy.

3. It is not appropriate to compare the increase in household income with the tax burden for typical households to compute a cost-benefit ratio. The income effects were experienced only by selected households, and the financing burden is distributed by the income and consumption characteristics of households.

4. The budget categories include the following items:

   Operations

   a. Administration of transportation operations
   b. Scheduling of transportation operations
   c. Revenue vehicle operation (including traction power costs)
   d. BART express bus service

   Maintenance

   a. Maintenance administration, planning and engineering
   b. Servicing revenue vehicles
   c. Inspection and maintenance of revenue vehicles
   d. Accident and vandalism repairs of vehicles
   e. Servicing and fuel for service vehicles
   f. Inspection and maintenance for service vehicles
   g. Maintenance of vehicle movement control system
   h. Maintenance of fare collection and counting equipment
   i. Maintenance of buildings, grounds, structures, stations, tunnels, bridges, subways and equipment

   i. Accident and vandalism repairs of buildings, grounds and equipment
   k. Operation and maintenance of electric power facilities
   l. Ticketing and fare equipment

   General Administration

a. Personnel administration, office management and services
b. Legal services and insurance
c. Data processing
d. Finance, accounting, purchasing and stores
e. Real estate management
f. General management
g. System security, safety, injuries and damages
h. Preliminary transit system development
i. General engineering
j. Customer services
k. Promotion, planning and market research
l. General function
m. Station and maintenance power

All information about BART costs and revenues in this section is from the BART Accounting Department and from the BART Annual Report for 1976-1977.

5. The transit components of the NBA were San Francisco's MUNI, AC Transit, and Greyhound's Contra Costa commuter service. The operating expenditures of the NBA and the with-BART transit systems are described in Appendix B.

6. BART's budget alone, without considering the reduction in budget for the other transit operators, would have a direct impact of $58.9 million and a total sales and income requirement of about $189.6 million.

CHAPTER 8

IMPACTS ON SPECIAL POPULATION GROUPS

SUMMARY

BART's impacts on minority, low-income, handicapped, and elderly persons are described in this chapter. These persons are very often dependent on public transportation. Many of them are inner-city residents. The travel advantages which they obtain from a new transportation system, and the impacts of a new system on their mobility, their access to jobs, and on their neighborhoods are important as indicators of social equity.

BART planning objectives did not place special emphasis on service to minorities and other special groups in the population. The special needs of transportation disadvantaged persons were not prominent matters of public concern during BART's planning period. The BART experience implies that rail systems which are designed primarily for service from the outlying areas of a metropolitan area are not likely to provide many travel advantages for the low-income population which is generally concentrated in central urban areas. Although low-income persons and minorities make up a large proportion of the residents in 21 of BART's 34 station areas, the system does not provide significant travel time savings for them. Buses served most of these areas before BART service began, and they have continued to provide service.

BART has aided minority and low-income residents of inner cities by encouraging firms to remain centrally located. It has been a factor in the decisions of several firms to remain in the older established cities. This has helped to maintain employment in areas readily accessible to inner-city low-income and minority persons.

BART is the mode of travel chosen by minorities roughly in proportion to their incidence in the population of the greater BART service area, but the rate of BART use appears to be lower for Blacks and Spanish-Americans in the smaller area close to BART stations (the primary service area). Because of the greater transit dependency of minority persons, BART is more frequently selected as a travel mode for work trips by minorities than by whites.

BART is accessible to disabled persons, including persons in wheelchairs. All BART stations have elevators designed for the use of persons in wheelchairs, and train doors are level with station platforms. In addition, restrooms in the stations are accessible to persons in wheelchairs, deaf persons can use a teletype machine to get information from BART, and the edges of platforms in many of the stations are textured for the safety of blind persons. The use of the system by disabled persons is increasing, but it is constrained by barriers in the urban environment which are beyond the control of BART.

DEMOGRAPHIC CHARACTERISTICS

The pattern of BART's impacts on minorities and other transportation disadvantaged groups is influenced by the demographic characteristics of each group.

The ethnic minority communities of the greater BART service area (San Francisco, Alameda, Contra Costa and Northern San Mateo Counties) represent nearly one-third (31.9%) of the approximately 2.5 million persons living in the area. The Spanish-heritage population is the largest of the principal ethnic subgroups (12.7%);Blacks are 11.8% of the population, and Asians 7.4%. A large proportion of the members of racial and ethnic minority groups live near BART lines and stations in the older urban areas of the central cities. Seventeen of the thirty-four BART stations are located in areas where minorities are 40% or more of the population. In addition, persons of Spanish heritage make up 36.3% of the population of the area around the Hayward Station. Table 33 shows the characteristics of the population in areas near the BART stations. (1)

Population statistics for the Bay Area indicate that the ethnic minority population is growing at a faster rate than the White population, and that minorities are increasingly concentrated in the central cities of San Francisco and Oakland. However, a counter-trend is becoming evident. The outward move from central cities to suburbs by White, middle-class persons is slowing and to some extent is being reversed. In San Francisco, and to a lesser extent in Oakland, there has recently been a strong demand for older homes for refurbishing by young single persons and couples. Although the proportion of minorities in suburban areas remains small, the Black population has increased proportionately much faster than the White population in some suburban Bay Area communities. (2) The relationship between the minority increase in suburban areas and the BART system is discussed later in this chapter.

Household incomes and educational levels are considerably lower for minority groups, particularly Black and Spanish-heritage minorities, than for the White population, on the average. Minorities have lower total employment rates and lower levels of employment in the downtown areas of the central cities, the centers best served by the BART system.

TABLE 33

SELECTED CHARACTERISTICS OF THE POPULATION
1970 CENSUS DATA FOR BART STATIONS

*Station Areas of High Ethnic Minority Concentration (+40%)

BART Station	Total Population within One-Quarter Mile[a]	Population Within One-Half Mile Radius[b]					
		Total Population	Percent Black	Percent Spanish Heritage	Percent Other	Percent of Total Minority	Median Income
1. Concord	997	5,650	0.0	7.0	2.2	9.2	$11,215
2. Pleasant Hill	785	3,166	0.2	7.0	2.6	9.8	13,346
3. Walnut Creek	763	3,600	0.3	6.4	1.8	8.5	10,744
4. Lafayette	727	--	0.3	3.5	1.2	5.0	16,400
5. Orinda	298	--	0.0	3.2	0.5	3.7	21,474
6. Rockridge	2,381	9,237	16.0	4.2	3.2	23.4	8,023
*7. Richmond	1,756	8,914	27.6	16.4	1.6	45.6	8,041
8. Del Norte	936	5,585	15.8	7.2	8.6	31.6	13,272
9. El Cerrito Plaza	1,607	9,250	2.4	7.8	5.3	15.5	15,176
*10. North Berkeley	2,533	11,553	25.7	8.2	14.3	48.2	9,398
11. Berkeley	3,795	20,813	7.0	4.8	10.0	21.8	7,187
*12. Ashby	3,116	20,215	59.1	4.2	3.4	66.7	7,756
13. Fremont	0	2,039	0.0	15.0	2.0	17.0	11,167
*14. Union City	0	--	0.0	86.0	2.0	88.0	8,400
15. South Hayward	1,763	1,519	0.2	21.7	2.7	24.6	9,562
*16. Hayward	756	4,565	0.2	36.3	2.7	39.2	9,175
17. Bayfair	1,283	7,883	0.1	18.5	2.8	21.4	10,710
18. San Leandro	903	5,976	0.0	23.3	2.2	25.5	10,320
*19. Coliseum	675	6,548	82.7	9.5	3.2	95.4	5,707
*20. Fruitvale	1,856	6,624	18.9	37.2	6.8	62.9	7,108
*21. Lake Merritt	2,042	5,158	10.5	4.9	33.7	49.1	7,965
*22. MacArthur	2,361	11,027	63.7	8.9	4.7	77.3	9,265
23. 19th Street	1,795	9,441	22.4	7.0	5.6	35.0	7,626
*24. 12th Street	1,115	7,921	25.2	9.7	16.8	51.7	7,334
*25. W. Oakland	2,240	6,295	89.4	5.0	1.6	96.0	4,711
*26. Daly City	2,219	10,417	25.5	19.0	8.7	53.2	10,373
*27. Balboa Park	1,898	14,686	11.8	20.5	8.8	41.1	10,952
*28. Glen Park	3,574	13,851	5.0	26.3	12.2	43.5	11,186
*29. Mission-24th	8,542	32,050	3.0	41.4	10.2	54.6	8,070
*30. Mission-16th	8,481	31,341	7.3	37.6	14.7	59.6	7,282
31. Civic Center	4,559	30,816	10.8	11.3	11.7	33.8	6,306
32. Powell Street	3,666	21,829	3.7	8.9	15.9	28.5	7,450
*33. Montgomery St.	402	25,919	1.7	5.3	50.2	57.2	7,416
*34. Embarcadero	621	11,795	1.8	4.9	50.0	56.7	9,387

[a] Census blocks within one-quarter mile of BART station. Source: DeLeuw, Cather & Co. Worksheets for BART Impact Population within One-Quarter Mile of Stations.

[b] Portions of census tracts within one-half mile of BART station. Source: Ref. 73.

In general, members of racial and ethnic minority groups make fewer trips by any mode than the majority population, but a substantially higher percentage of the trips they do make are on public transportation. Table 34 illustrates the travel mode choices of members of racial and ethnic population groups in the BART service area.

TABLE 34

TOTAL VEHICLE-TRIPS BY TRAVEL MODE AND ETHNIC CATEGORY
IN THE BART SERVICE AREA
(Rate per seven-day week of trips by persons 16 years of age and older)
(May, 1975)

	WHITE		BLACK		OTHER*		ALL PERSONS	
	Rate	%	Rate	%	Rate	%	Rate	%
Auto (drive and ride)	19.24	89	11.41	81	4.20	75	15.51	88
BART	.32	2	.28	2	.29	5	.31	2
Bus, Streetcar	2.01	9	2.40	17	1.10	20	1.88	10
All Modes	21.57	100	14.09	100	5.60	100	17.73	100

*Includes Asians, persons of Spanish heritage, and others.

Source: Ref. 75.

ENVIRONMENTAL IMPACTS

The adverse effects of BART's construction were generally more pronounced in central city areas where the minority population is concentrated, and where BART facilities were placed underground. Both the severity and the duration of the impacts were greatest in these areas, particularly when cut-and-cover construction methods which produce noise, dust and disruption were used. The length of the construction period ranged from one to four years in neighborhoods where the BART line is underground; in neighborhoods where the BART line is above-ground, construction required between six months and two years. On the other hand, BART operations produce virtually no adverse environmental impacts in central city areas where the minority population is concentrated, because the BART facilities are underground in those areas.

IMPACTS ON TRAVEL TIMES AND MOBILITY

BART's most important advantages for travel are experienced by suburban residents who commute to downtown central city areas. Minority persons in the central cities do not receive important travel advantages as a result of BART, partially because the system is not designed to facilitate intra-city trips, and partially because the central cities have extensive bus services. BART does provide good transportation

service from San Francisco and central Oakland to some areas near industrial employment centers in the East Bay. However, these industrial centers are generally not directly adjacent to BART and little, if any, coordinated feeder service is provided to them from BART. Therefore, BART has not made trips to blue-collar employment centers from the central cities measurably faster or easier.

BART's impacts on travel times to non-work activities have been minor for both disadvantaged groups and for the majority of persons in the population. However, the system was not providing service on Saturdays during much of the period of the Program's work, and service on Sundays began in July, 1978, after the Program's data gathering activities had been completed. Weekend service and improved service on weekdays may result in increased benefits for travel to social, cultural and recreational activities for all residents of the BART service area.

LEVEL OF MINORITY RIDERSHIP(3)

The proportion of ethnic minority persons who ride BART is roughly similar to their proportions in the greater BART service area (GBSA), the area in which 96% of all BART trips originate. (The GBSA is the three-county BART District plus northern San Mateo County.) The one exception is ridership by persons of Spanish heritage, which apppears to be lower than the representation of this group in the population.(4) In the more immediate area around the BART system which accounts for the origin of about 80% of the trips made on the system (the Primary BART Service Area, or PBSA, illustrated in Figure 12), the rate of ridership by both Spanish-heritage and Black persons in the PBSA appears to be lower than the rate for the White population. Table 35 compares ridership on BART by members of racial and ethnic groups in the Bay Area with their distribution in the population of both the GBSA and the PBSA.

Although the rate of ridership on BART is lower for some minority groups than for White persons, the system has increased mobility for minorities, particularly Blacks, more than for the White population as a whole. This is a reflection of the greater transit dependency of Black persons. For example, 14.7% of Black respondents to the 1976 Passenger Profile survey indicated they had not made the same trip prior to BART's service because they had had no means of transportation available for the trip. Only 8.1% of the White respondents gave that reason for not making the trip prior to BART's service. Comparable rates for Asians and Spanish-heritage persons were 9.2% and 11.1% respectively. Approximately half of both Black and Spanish-heritage BART patrons told interviewers that they had no automobile available for the trip they were making on BART, compared to 36.2% of the White BART patrons. (1976 Passenger Profile Survey, Ref. 36.

TABLE 35

RATE OF BART USE BY ETHNIC CATEGORY
(Persons 16 Years of Age and Older)

ETHNIC CATEGORY	BART USE:RATE PER 100 RESIDENTS IN EACH AREA*	
	Greater BART Service Area	Primary BART Service Area
White	7.2	9.8
Black	7.3	7.7
Spanish-heritage	3.6	4.3
Asian and Other	9.4	12.1
Total	7.0	9.0

*Rate derived from Passenger Profile Survey, May 1976.

Source: Ref. 75.

Ethnic and racial minority persons more frequently choose BART as their principal mode for travel to and from work than do persons who are White. The data in Table 36 illustrate this choice.

TABLE 36

PROFILE OF BART USE FOR WORK TRIPS BY ETHNIC CATEGORY
(Workplace Survey Area)*

ETHNIC CATEGORY	EMPLOYMENT (No.)	% WHO COULD USE BART	BART PRINCIPAL MODE (%)	BART PRINCIPAL MODE, OF THOSE WHO COULD USE BART (%)
White	293,022	34.9	11.4	32.7
Black	55,513	31.5	14.3	45.4
Spanish	44,093	32.2	16.9	52.4
Asian	70,021	30.2	13.1	43.3
Other	9,786	32.2	14.4	44.7
Total	472,435	33.5	12.6	37.5

*The survey queried persons who work within a short distance of BART stations. The survey area included the destinations of virtually all work trips made on BART.

Source: Workplace Survey, 1977.(Ref. 38)

CHARACTERISTICS OF MINORITY BART PATRONS: A comparison of the income levels of BART riders with the estimated 1975 household income distribution of various groups in the population of the three-county BART District is shown in Table 37.

TABLE 37

COMPARISON OF HOUSEHOLD INCOME DISTRIBUTION BY ETHNICITY:
THREE-COUNTY BART SERVICE AREA POPULATION VERSUS BART USERS

	1975 Population Estimate(a)			BART Users - Daytime(b)		
	Black	Spanish	White & Other(c)	Black	Spanish	White & Other(c)
1. Under $7,000	32.8%	17.8%	12.9%	20.2%	17.7%	15.2%
2. $7,000 to $9,999	15.2	11.2	8.3	19.0	21.1	10.0
3. $10,000 to $14,999	22.0	22.6	17.4	20.6	24.9	17.3
4. $15,000 to $24,999	27.3	33.5	36.7	24.8	26.7	31.7
5. Over $25,000	2.7	14.9	24.7	15.3	9.5	25.8
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

(a) Source: 1970 U.S. Census of Population: General Social and Economic Characteristics. Adjusted distribution to estimate 1975 family incomes using transition factors utilized in the Transportation System and Travel Behavior Project. Ref. 40.

(b) Passenger Profile Survey 1976. File WX. Daytime Survey (6:00 AM to 3:00 PM). Crosstabs: Urban Dynamics Associates.

(c) Other: Total persons minus Blacks and Spanish. Includes Asians, but is predominantly White.

BART riders who are Black generally have higher incomes than do Black persons in the population as a whole. Persons of Spanish heritage, Whites, and others who are BART patrons have somewhat lower incomes, on the average, than these groups in the population as a whole. Compared to White BART users, minority riders are more predominantly female and generally younger. They also have lower incomes, a reflection of their generally lower-income status in the population as a whole.

Compared to White BART users, minority riders are lower-income; BART patronage surveys show that they are also more predominantly female, and generally younger.

ECONOMIC, EMPLOYMENT AND FINANCIAL IMPACTS

One of the principal economic benefits provided by BART for minority persons has been the employment opportunity provided by the BART District itself for the construction of the system and for its continuing operations. The percentage of minorities in the construction work force was 36%, considerably higher than the 22% participation of minorities in the regional construction work force at that time. As discussed in Chapter 7, minorities were most often employed as laborers during the construction period, and as such received no training in a job skill which would improve their employment opportunities after BART construction was completed. However, the BART District's affirmative action policies served to introduce the concept of equal opportunity employment to many contractors in the area. The BART District employs about 750 minority persons on a permanent basis for its operations, and many of the jobs are in skilled trades or in administrative positions.

The taxes which fund the local share of BART capital costs and its operating deficit are regressive; that is, low-income households, many of which are minority households, pay a larger percentage of their incomes to support BART than do high-income households, as they do for most locally-funded urban services. (This issue is discussed further in Chapter 7.)

The BART fare structure, which is graduated for distance of travel, is more equitable in terms of its impacts on low-income minority residents than a flat fare system would be, since minority persons generally make shorter trips on BART than do white persons. But the fare per mile of travel on BART is higher for short trips than for long trips, so minorities pay more, on the average, for each mile of travel on BART than do White persons. (Ref. 75)

BART's influence on employers' location decisions has been small to date, but not insignificant. Interviews with employers indicate that some have been influenced by BART to remain in a downtown area. This has increased the likelihood for greater minority employment. For instance, the Social Security Administration located in Richmond partially because BART provides service to that city. It has provided a source of employment for Richmond residents, many of whom are lower-income Black persons. (Ref. 52) An employer's decision to move to a suburban area rather than to locate or remain in a central city would reduce the number of jobs available to minority workers. Therefore, BART's role in influencing employers to remain in areas accessible to large concentrations of minority residents is important.

LAND USE AND URBAN DEVELOPMENT IMPACTS

BART has had minimal effects, to date, on regional demographic patterns in the Bay Area. The system has not caused White, middle-class persons to move from central cities. However, the Black population has increased faster, proportionately, than the White population in several suburban areas which have been studied. For example, in Union City the

Black population increased eightfold, while the White population doubled between 1970-1975. Fremont, a neighboring community at the end of the BART line in southern Alameda County, was another community where the increase in the Black population was proportionately greater than the White population gain (300% compared to 10%). There is evidence that the growth of the Black population in suburban areas may have been influenced to some extent by BART service.

For instance, Black persons who have moved to Fremont use BART more frequently than White persons in Fremont. This suggests that the Black movers to the area may have been more strongly influenced by the availability of BART's service. For trips to work, 5.7% of Black heads of households in Fremont use BART, compared to 3.4% for White heads of households. A similar relationship was found in Union City. Analysis of the 1974 Fremont special census suggests that the higher use of BART by Blacks for work trips is probably related to their higher rates of employment in downtown Oakland and San Francisco, areas to which BART provides accessibility advantages. While 9.9% of the White Fremont residents worked in Oakland, and 5.4% in San Francisco, the equivalent percentages for Black Fremont residents were 17.2% and 8.7%, respectively.

BART has had no evident effect on the quantity or quality of housing available to minorities in central cities. Any impact on the housing market in central cities from BART-related moves to the suburbs may have been offset by other factors, such as inflation and gasoline price increases.

BART's major contribution to the physical upgrading of station areas where minority groups are concentrated has occurred where BART has influenced public capital improvement expenditures, land use policies and regulations, or redevelopment planning. There are minority population concentrations in areas of public improvement expenditures in Richmond and Oakland. In addition, minor street improvements were provided in the Spanish-heritage area of the San Francisco Mission District.

BART has not induced increases in the rehabilitation of existing housing or office buildings in minority areas around stations. This is due to the depressed economic conditions in many of the areas, and to restrictive zoning in several station areas which prevents any large influx of new investment which might have occurred in response to BART.

IMPACTS ON DISABLED PERSONS

BART has demonstrated that rapid transit facilities can be substantially barrier-free. The system is accessible to persons with a wide variety of physical disabilities, including persons in wheelchairs. However, there are many obstacles to the travel of disabled persons in the urban environment which cannot be controlled by BART. These include a lack of feeder services to BART stations which can be used by persons in wheelchairs, and a lack of curb cuts on streets in many neighborhoods served by BART. The use of BART by disabled persons is probably less extensive than it would be if barriers to their travel to BART stations could be removed.

Disabled persons may purchase BART tickets at a 75% discount. Among persons surveyed in the 1977 BART Passenger Profile Survey, 1.4% reported using a discount ticket for disabled persons. About 2% of the persons surveyed reported that they had a physical or other type of disability which made travel on BART difficult. (Some disabled persons may also be elderly; elderly persons use a special discount ticket which provides a 90% discount.) BART patronage statistics indicate that the use of BART by physically disabled persons is increasing faster than overall ridership. (Ref.69) This suggests that disabled persons' use of BART may become more extensive as their familiarity with the system increases.

HANDICAPPED PERSON BOARDING BART

IMPACTS ON THE ELDERLY

Elderly persons do not ride BART in proportion to their representation in the general population, despite the fact that persons sixty-five years of age and older receive a 90% discount on the system. Interviews among senior citizens in downtown Oakland, an area which includes a large percentage of elderly residents, suggested some of the reasons why these people might prefer the bus. Most of their trips are short, and BART is not designed to serve most short trips. Some elderly persons indicated that they were unfamiliar with BART and somewhat apprehensive about using the system. Some mentioned access problems such as long distances between their homes and a BART station, or difficulties in using BART's fare equipment, escalators, and elevators. Some were unaware that discount tickets were available to them.

The elderly persons who do ride BART frequently use it for shopping and recreational purposes, reflecting the fact that, for them, a BART trip is an inexpensive outing. They also use BART for visiting friends and relatives.

One-fourth of the persons sixty-five or older riding BART who were making trips not previously made by another transportation mode said that they had not previously had a means of transportation for the trip. Therefore BART has increased their mobility.

FOOTNOTES TO CHAPTER 8

(1) Elderly persons tend to be concentrated in older urban residential areas where many minorities live. Therefore, many of the conclusions about BART's impacts on minority residents apply to low-income elderly residents of the Bay Area.

(2) This conclusion is based on an analysis done by the Land Use and Urban Development Project of the Impact Program for selected cities in Contra Costa County and Alameda County. The communities chosen were those for which special censuses were conducted in 1974-1975, which were located near BART or beyond end-of-line BART stations where some BART trips originate.

(3) Unless otherwise indicated, all information about BART riders in this section is from the May, 1976 Passenger Profile Survey. (Ref. 37)

(4) The U.S. Census definition of Spanish heritage and surname is not strictly comparable to the ethnic identity reflected in the BART Passenger Profile Survey. The Survey asked patrons to identify their ethnic/racial characteristics in the category which most closely defined them. Some Spanish-heritage or Spanish-surname patrons may have identified themselves as "White."

The categories representing Spanish, Asian and "other" racial/ethnic groups in the tables in this chapter are not consistently defined because the data is derived from a number of different sources. The data bases vary and could not be reconciled.

SUMMARY AND CONCLUSIONS

SUMMARY

BART, the San Francisco Bay Area's rail transit system, was designed and built to serve major travel corridors in the region's central counties--San Francisco, Alameda, and Contra Costa. Its lines extend from Oakland to San Francisco, and into the suburban areas of the East Bay. A single BART line serves each of the central cities. BART stations in the downtown areas of the central cities are closely spaced to provide access to workplace locations. They are spaced two to four miles apart in suburban areas. Bay Area residents, when they voted to authorize its construction, expected BART to provide the necessary capacity to serve a growing demand for travel in the region's major transportation corridors, to sustain and encourage a high level of economic and social activity, and to encourage a city-centered growth pattern.

The BART Impact Program studied a comprehensive range of BART's impacts during the first five years of the system's operations. They included impacts on the transportation system, traffic flow, travel behavior, the environment, land use and urban development, the economy, institutions and life styles, and government policies concerning transportation. The program also analyzed BART's positive and negative effects on population groups, local areas, and economic sectors.

The Program's evaluations of BART are based on comparisons of changes which have occurred in the Bay Area with BART and estimates of those likely to have occurred with a hypothetical "No-BART-Alternative" (NBA) system if BART had not been built. Based on a study of transportation planning and policies in the area in the past, it was judged that few changes would have been made in the transportation system by 1976 in the absence of BART. Therefore, the NBA is similar to the transportation system in place just before the beginning of BART's transbay service. If the system's impacts had been compared with those of new highway developments or of a high-quality regional express bus system the evaluations would have been different in a number of respects. (See Chapter 1 and Appendix B for further descriptions of the Program and its methodology.)

OVERVIEW OF BART'S IMPACTS

The decision to build BART was based on two primary assumptions:

- The vitality of the major cities in the Bay Area was endangered by increasing traffic congestion in the major transportation corridors. In the words of the engineering consultants to the Bay Area Transit Commission in 1956:

  > "The choice is between preserving the system of concentrated regional and sub-regional centers, or dissipating their activities to diverse non-central locations." (Ref. 13, p. 10)

- A modern, efficient rail transit system would provide the additional transportation capacity needed to permit continued growth in the urban centers, without the expensive and disruptive construction of additional freeways and bridges. (Ibid., p. 106)

In its first five years of operations, BART provided added transportation capacity in topographically-constrained corridors in the central Bay Area with a minimum of environmental disruption. The system absorbed most of the increase in peak period travel in the two most heavily-traveled corridors leading to San Francisco and Oakland. It thereby permitted a larger volume of travel to these cities than would have been possible without increased traffic congestion or other additional travel facilities.

BART's primary impacts on development patterns occurred in business and commercial areas where public policies and market demand helped to encourage the location of new office buildings in the station areas. The system also influenced the timing and location of some new residential projects. These impacts generally occurred beyond the station areas, in part because housing does not have to be close to transit stations to provide access to them in auto-oriented communities. When nearly every household has at least one automobile, rail transit represents a marginal increase in accessibility which cannot, by itself, have the nucleating effects which occurred when other means of transportation were scarce and people had to live within walking distance of transit stations.

No region-wide impacts on development patterns occurred as a result of BART during its first five years of operations. Neither overall regional growth nor the distribution of population and economic activities between central cities and suburbs were affected. However, within the counties served by BART, employment increased most rapidly in the relatively narrow corridors along BART lines. The system encouraged some firms to remain centrally located and it was a factor in the decisions of a few firms to locate in the central cities. In this manner the system helped to maintain the economic stability of the traditional city centers.

BART's influence on urban development patterns often could not be isolated from the primary factors affecting Bay Area land uses. These include over-all levels of economic activity; market demand for new development in the communities served by BART; the price and availability of land; the extensive system of freeways and highways; and public policies. In some instances BART's impacts worked together with other influences to produce land use changes. This occurred in downtown San Francisco where civic improvements and zoning changes, together with BART's service, resulted in decisions to locate the majority of office space added since 1962 within walking distance of a BART station. In other locations any potential BART impacts were precluded by factors such as unfavorable economic conditions and public policies. For example, station areas which were not attractive for new housing or commercial development did not experience any land use impacts as a result of BART because of a lack of market demand. In addition, several residential and commercial station areas were downzoned to protect the character of the neighborhoods from any changes which BART might have induced. The system had no land use impacts in these areas.

It is likely that BART's land use impacts will become more widespread in the future. Large-scale land use changes tend to occur slowly, and BART's service is relatively new. Moreover, the system influenced some residents' choices about where to live, work, and shop. As BART's ridership increases and as driving becomes less attractive, due to gasoline shortages or to increased traffic congestion, its influence in this regard will be likely to increase. BART can then be expected to become a more important factor in choices of locations for homes, offices, and retail stores. However, the extent of future impacts will depend on improvements in BART's service, on increases in patronage, and on the support of public policies and economic conditions.

The total capital cost of BART was $1.6 billion, of which 80% was locally funded, largely from the proceeds of general obligation bonds backed by property taxes. Although local expenditures for both the system's construction and its operations have been substantial, they have not produced notable impacts on the Bay Area's economy. In the context of the high level of economic activities in the area, these expenditures represented only a fraction of a percentage of total sales and income. Nor did the BART debt increase the cost of borrowing for other public projects or cause voters to refuse to endorse further bonded indebtedness. (The implications of this aspect of the BART experience are probably limited. The analysis covered the years 1962-72. The current problems of a number of major cities with debt payments, and the spread of property tax limitation laws, such as California's Proposition 13, have introduced new constraints on public borrowing in many places.)

BART carried 146,000 one-way trips per day in late 1978. Early forecasts of the system's ridership, which predicted over 250,000 one-way trips per day, were based on unrealistic expectations of the level of service to be provided. An unexpectedly large number of equipment problems and some technical limitations became apparent when BART operations began. They have resulted in delays in implementing some services; in trains operating at 5-6 minute intervals rather than at the 90-second intervals anticipated for some routes; and in unreliable service. BART has devoted considerable resources to solving its problems. As a result, system reliability has improved, and increases in services are planned for the next year or two. However, patronage forecasts have been revised to reflect more realistic expectations of the level of operations. Current forecasts indicate that the system will serve 180,000 one-way weekday trips by 1981.

A brief summary of findings in the major impact areas studied by the Program follows.

IMPACTS ON TRAVEL BEHAVIOR AND THE TRANSPORTATION SYSTEM

BART is an important transportation resource in the central Bay Area. It is also somewhat specialized. As a regional system, designed primarily to serve suburban-to-central city trips, BART's greatest travel advantages are for relatively long trips.

Travel times for many trips on public transportation in the central Bay Area have been shortened by BART's service. The greatest time savings are for trips between suburban communities and the downtown areas of central cities. BART service is competitive with automobile travel times only for relatively long suburban-to-central-city trips, particularly in peak travel periods when the highways are sometimes congested. There are several reasons for this:

- The major cities in the central Bay Area had good local transit service prior to BART. BART, which has a single line in each of the central cities, does not provide time savings in comparison to trips on the extensive network of routes of the older local transit services.

- By contrast, many suburban areas served by BART had inadequate public transit service or none at all prior to BART. BART's frequent service during both peak and off-peak travel periods between the suburbs and the central cities represents a considerable improvement over the pre-BART situation.

- BART's station spacing also affects the relative advantage of long trips on the system. Stations in suburban areas are two to four miles apart. For short trips, the time required to get to a station is a significant proportion of the total trip time for many travelers. It represents only a minor proportion of the total travel time for many long trips, however.

BART offers considerable cost savings over travel by automobile, particularly for transbay trips which involve bridge tolls, and for trips which involve parking charges. Currently, BART fares for most trips are somewhat higher than bus fares.

The relative advantages of travel by BART, buses, and automobiles are reflected in travelers' choices between them. Among commuters in BART's primary service area whose choice was between BART or a bus, 54% chose BART. Among those choosing between BART and an automobile, 27% chose BART. (BART's primary service area is the area near the system's facilities where 80% of the trips on BART originate.)

The characteristics of trips made on BART reflect the system's regional design and its travel advantages.

- Two-thirds of all BART trips are trips to or from work, and half of all trips are made during the four peak hours of travel. About 10%

are trips to or from colleges and universities in BART's service area.

- The average length of trips made on BART is 13 miles.

- To get from their homes to a BART station, 60% of BART's patrons use an automobile, 20% walk and 20% take a bus. Almost 80% walk from BART to their final trip destinations.

A May 1976 survey of BART patrons indicated that over half (55%) of those who had made their trips by another form of transportation before they started using BART had traveled in automobiles. Forty-three percent had used buses. About 28% of all the patrons had first started making the trip via BART, most of them because they had moved or changed jobs after BART service began. Between 5% and 10% of all patrons would not have made the trip at all except for BART -- for the most part because they did not have other convenient transportation available to them. Some new trips have been made in automobiles in the corridors BART serves because BART made space available by diverting motorists to the rail system. The share of trips served by BART varies considerably by geographic area and type of trip.

- BART serves about 2.5% of the trips made by all forms of transportation in its greater service area--the three BART District counties plus northern San Mateo County.

- The system carries 27% of peak period trips in the transbay corridor and 31% in the Caldecott Tunnel Corridor which connects suburban Contra Costa County with Oakland and San Francisco.

- Of the work trips which are made by commuters living within its primary service area, BART carries 27% of all those to downtown San Francisco and 29% of those to downtown Oakland.

The total volume and speed of traffic in the transbay corridor has not been affected by BART, despite the substantial proportion of peak period trips made on the system.

- The immediate effect of the introduction of BART service in the transbay corridor was a reduction of traffic volumes equal to about two years' historical growth.

- Within two years the trips diverted to BART had been replaced. The "new" trips were probably trips which had been made previously by other routes, trips which had not been made because of traffic congestion, or trips resulting from local population growth and changes in economic activities.

This aspect of the BART experience is consistent with experience elsewhere where the capacities of congested corridors have been increased by the addition of new highway space or new transit services. New capacities in corridors where travel demand is high and increasing have invariably led to a rapid increase in the number of trips made.

BART was planned before the Metropolitan Transportation Commission, the transportation planning authority for the Bay Area, was created, and there was no other central authority to coordinate the services of the separate transit operators in the area. Local bus operators rerouted some lines to provide feeder service to BART stations, and reduced service on others, particularly on transbay lines, when BART service was introduced. Although local buses have lost some long-distance riders to BART, their patronage has increased on the feeder service lines. Many bus routes provide parallel service to BART, and full coordination of transfer systems and fares between BART and local bus operators has not been achieved. Currently, progress is being made toward implementing a regional coordination policy.

ENVIRONMENTAL IMPACTS OF BART

BART has been integrated into the Bay Area with a minimum of environmental disruption because it is located in established travel corridors and because it was well designed, with consideration given to the characteristics of neighborhoods in which the facilities are located. The massive bulk of the BART elevated structures, for instance, is minimized by T-shaped support pillars. The stations are generally compatible in appearance with their neighborhoods, and landscaping has been used extensively and effectively to soften the appearance of the facilities. Visual improvements have accompanied the BART lines in some areas. The most notable example is a 2.7-mile linear park along the elevated trackway in Albany and El Cerrito. The perceptions of persons most directly and continuously exposed to the system's impacts, the residents near the BART facilities, indicate that the BART design, with some exceptions, successfully minimized the system's impacts.

- Residents near BART lines and stations generally perceive BART's over-all impacts--its service, costs, and environmental impacts--favorably. When asked specifically about the system's environmental effects, the majority indicated that they were pleased with them.

- Most residents near BART regard its facilities as assets to their neighborhoods or they are indifferent to their appearance.

The persons most frequently displeased with BART's environmental impacts are those who live near the elevated trackways. The major problem perceived is the noise of passing BART trains.

- The sound generated by BART trains is roughly the equivalent of the sound generated by a passing delivery truck.

- Along about seven miles of the BART trackway the daytime time-averaged sound of BART exceeds community background sound levels by varying amounts, ranging from perceptible to substantial. The effect falls mainly on dwellings within one block of the trackways.

- The factors important to the intensity of BART's train sound include the elevation of the right-of-way, train speed, track and wheel

condition, train length, the frequency of service, and the presence of switches and curves.

BART trains do not cause significant noise around the stations, largely because they slow and stop quietly.

Residential neighborhoods around some heavily-used BART stations have experienced adverse effects from increased traffic caused by BART patrons driving to and from the stations. Overflow parking from some BART lots has caused inconvenience to near-by residents. BART has acted to resolve this problem by expanding the parking lots in a number of station areas where overflow parking has occurred. Nonetheless, providing additional parking and the related goal of improving access remain high priority objectives for BART planners.

BART operations are relatively pollution-free in comparison with automobiles, and they result in a small but measurable improvement in regional air quality. The system will reduce the pollutant emissions from automobiles in the BART counties by about three percent at full service levels.

BART is also energy-efficient in comparison with automobiles. As an electrically-powered system, BART can utilize power generated from non-petroleum sources. This flexibility to utilize alternative sources of energy may become significant in the future if petroleum shortages are experienced, and if alternative energy sources are developed. Because BART has resulted in an increase in the share of trips made by public transit in the corridors it serves, the system has helped to reduce the rate of growth of transportation energy use.

The environmental impacts of the construction of BART varied in severity.

- The consumption of land for BART facilities was not extensive. Slightly more than a thousand acres were acquired. Most of this land was undeveloped or was being used for transportation purposes.

- About 3,000 households were displaced. This was far less than the displacement required for freeway construction. For example, a stretch of freeway in Oakland only three-and-one-half miles long also displaced 3,000 households.

- The construction method which produced the most adverse impacts was cut-and-cover subway construction. It disrupted auto and pedestrian traffic, reduced parking spaces, and created dirt and noise. Its duration was considerably greater than that of the above-ground construction of BART facilities. Although cut-and-cover subway construction created substantial environmental effects while it lasted, the operating system in its subway segments produces no environmental impacts.

ECONOMIC AND FINANCIAL IMPACTS OF BART'S CONSTRUCTION AND OPERATIONS

Neither the large expenditure of funds for BART nor the burden of repaying the local share of BART's costs have produced major economic and financial impacts in the Bay Area.

- The system was built during a period when the Bay Area economy was operating at a high level.

- The expenditures to build BART resulted in the purchase of $1.2 billion of labor, materials, and services within the nine-county Bay Area. The total impact on sales and income in the region, considering both the direct expenditures and the expenditures induced and spent for intermediate purchases of services and materials, was $3.1 billion during the thirteen-year construction and procurement period, 1964-76. In no single year did BART's economic impacts exceed one-half of one percent of the total gross regional product.

- Financing the BART system did not increase the cost of public borrowing within the region, nor did it affect the willingness of local governments to use general obligation debts to finance other local public improvement projects. (These conclusions are based on the analysis of data covering the years 1962-72.) This is noteworthy because 80% of the $1.6 billion capital cost of BART is financed from local sources. Inflation and the increase in the tax base which has occurred since the BART bond issue was passed in 1962 has diminished the relative burden of the BART general obligation bond debt.

Operating expenditures for public transit (BART, buses and streetcars) in the BART counties in the fiscal year 1975-76 were about $47 million more than would have been spent for the hypothetical NBA transit system. Part of the difference arises because the with-BART system provides more service and carries more patrons than the NBA. The direct and indirect effects of employment for BART operations have resulted in about 3,000 permanent jobs in the region.

The majority of local taxes used to repay BART's capital costs and to subsidize its operations fall on households, in the form of property and sales taxes. Property taxes for BART represented about 4% of the total property tax bill in most BART District communities in 1976. An affluent family of four paid a total of about $153 in sales and property taxes to support BART's capital and operating costs in 1976. A poverty-level family of four paid about $21. As a family's income decreases, the BART taxes represent a progressively greater percentage of that income. In this respect the BART taxes tend to be regressive, as are taxes for other urban services supported by the same tax base.

IMPACTS ON THE LIFE STYLES OF BAY AREA RESIDENTS

BART was built in major, heavily-used traffic corridors to serve existing and forecast centers of population. For this reason it has not generated

major new travel patterns in the Bay Area, and it has not produced extensive impacts on the life styles of its users.

- Commuters, who are BART's most frequent riders, have experienced only minor life style impacts. For some, the timing and scheduling of work trips has been affected.

- A few students who use BART report that the system has enabled them to live farther from the campus that would otherwise be possible, thereby lowering their housing costs. BART makes colleges in its service area more accessible for students who do not have access to automobiles or to good bus service.

- Children and young people report that BART gives them increased mobility and independence, and parents are called on to do less chauffeuring.

- BART has increased the mobility of some elderly and some handicapped persons. Older persons and those with disabilities do not ride BART in proportion to their numbers in the population, despite the discount fares available to them, and the fact that BART is accessible to persons in wheelchairs. However, older persons and handicapped persons make proportionately fewer total trips than the population as a whole. The trips they do make are often not the suburban-to-central-city trips BART serves best. For handicapped persons, getting to a BART station is sometimes a problem because the feeder buses operated by local agencies are not accessible to persons in wheelchairs, and because other aspects of the urban environment, which are beyond the control of the transit operators, create barriers.

BART has demonstrated that a modern rail transit system can extend the market for public transportation to some segments of the population who do not generally use public transit. BART riders are generally younger and better educated than the population of the BART service area. In contrast to many other public transit systems, BART is used by high income groups roughly in proportion to their distribution in the population.

Although low income and minority groups also use BART approximately in proportion to their numbers in its service area, the system's service does not generate a progressive distribution of benefits. Inner-city residents, many of whom are minority and low-income persons, receive fewer travel advantages from BART than do suburban residents who commute to the central cities. As mentioned elsewhere, the inner cities were well served by public transportation before BART was introduced, and BART provides few travel advantages in comparison with the older transit services within the cities.

BART benefitted minorities through the employment and income generated by its construction and continues to provide such benefits through its operations. BART's construction activities introduced the concept of equal employment opportunity to many contractors in the area. Today minorities constitute nearly half of BART's work force, and 19% of BART

employees are women.

An additional benefit accrues to central city residents from BART's role in helping to maintain jobs which are readily accessible to inner-city residents, by reinforcing continued centralization of office employment and supporting downtown retailing.

IMPACTS ON LAND USE AND URBAN DEVELOPMENT

BART's most notable land use impacts to date have occurred in the downtown areas of San Francisco and Oakland. The system has affected the timing and location of new office construction in these areas both directly, as a result of its service, and indirectly, as a result of public policies and civic improvements that BART helped to bring about.

- In downtown San Francisco, BART has contributed to a redirection of new office-building construction toward Market Street, where the BART stations are located. The Market Street area has experienced a dramatic rise in its share of downtown office construction. No new office buildings were constructed there prior to the decision to build BART (1960-1962); in the period 1974-1977, after the beginning of BART's transbay service, the Market Street share was almost 90%. Most of the 22.5 million square feet of office space built in downtown San Francisco since 1965 is within 1,500 feet of a BART station.

- Two events for which BART was a catalyst have been the primary influences for this shift. One is a $35 million Market Street beautification project; the second is the adoption of new zoning policies to encourage development near the BART stations.

- BART service itself was a factor in influencing the location decisions for seven major projects built in downtown San Francisco near the BART stations since 1965. This represents about 10% of the total office space added.

- The price and availability of land, zoning constraints on growth in some other directions, and access to other forms of public transportation have also played major roles in the redistribution of office space in downtown San Francisco.

- In downtown Oakland a much smaller total amount of new office space has been added. However, BART played a role in influencing the location decisions for a majority of the new space. The system's most important influence was its role in the expansion of the downtown City Center Redevelopment Project. The redevelopment area was expanded to include a BART station, and the expenditures for the station were used as part of the local matching funds to secure federal funds for the Project's expansion.

Increased office construction has also occurred near BART stations in Richmond, Berkeley, and Walnut Creek. The total amount of new space has been small in these cities, and BART's influence on its location was less

important than it was in San Francisco and Oakland.

Commercial development has been more strongly affected by BART than residential development. This aspect of the BART experience illustrates a number of the factors which determine a rail transit system's ability to influence land uses in the communities it serves.

- Public policies and incentives encouraged commercial developments near BART stations in the central cities. By contrast, neighborhoods around the transit stations in a number of residential or mixed residential-commercial areas were downzoned. This was done in response to residents' demands to protect the character of the neighborhoods. It prevented any BART impacts on land uses in these areas.

- The prevailing preference for single-family homes in suburban areas served by BART has discouraged higher density developments, particularly in fast-growing communities along the BART Concord line.

- Homes need not be located within walking distance of a BART station in residential communities where parking spaces are provided, and where nearly every household owns at least one automobile.

- Little vacant land is available for development in most BART station areas. The cost of acquiring and demolishing existing housing discourages developers from undertaking new, higher-density construction in these areas.

- Some outlying station areas are not attractive for residential development because of the ambiance created by large BART parking lots and related increases in traffic on nearby streets.

- Along a section of the BART line in Union City and Fremont where the noise of passing trains exceeds community noise levels, residential development has not occurred. This is an area with strong market demand for new development. Interviews with knowledgeable persons confirmed that the noise of BART trains has prevented new development in the area.

In general, the BART experience illustrates the importance of placing rail transit facilities in areas with good development potential to achieve land use changes. Some BART stations are located in areas where there is little commercial activity and where nearby housing is deteriorating. In some cases BART is isolated from activity centers by areas of land-intensive light industry or by railroad tracks and freeway structures. There is little likelihood of new developments in these areas, and none has occurred.

BART's impacts on the location of retail establishments has been slight. Retailers in downtown central cities report that bus and streetcar services have been more important than BART service in influencing their location decisions. In suburban areas automobile access is considered to be of primary importance. The lack of established week-end BART service when the study was made may be an important reason for retailers' virtual

disregard of BART in their location decisions. Weekend service has since been initiated.

BART has had few permanent effects on property prices and rents, to date. The system's major impacts in this regard occurred during its planning and construction, when prices in some station areas increased temporarily in anticipation of the benefits of BART service. Since BART operations began these impacts have disappeared in most areas.

Some of BART's most important impacts to date are on behavior patterns.

- Among respondents in a work-travel survey who had recently changed or obtained jobs, one in four sought the job with the intention of commuting by BART. (The survey was stratified so that half of the respondents were BART riders. Therefore, the extent of BART's influence is overstated.)

- BART is becoming a common influence on residents' choices about where to move. About half of the respondents to a survey among people who had recently moved reported considering BART in their choice of a place to live. The system was not an influence on decisions about whether to move, however.

- BART may be causing some changes in shopping patterns. Among shoppers who had increased their use of a BART-served shopping area since 1974, one in four reported BART as a reason. (This survey was also stratified so that half of the respondents were BART riders, thereby overstating the BART influence.)

- BART has influenced the location decisions of a few major employers. Five employers among representatives of fifty organizations interviewed indicated that their location decisions were influenced by BART. All located in the older central cities. The interviews also indicated that BART has encouraged some firms to remain in the central cities.

BART's impacts on behavior patterns suggest that the system's most significant land use and urban development impacts may occur in the future. BART's impacts on shopping patterns and on choices of residence and work locations may eventually lead to more widespread impacts on the distribution of homes, shops, and workplaces. Moreover, BART's service is relatively new, and large-scale land use changes tend to occur slowly. Many impacts may not yet have had time to develop.

CONCLUSIONS

The BART experience points to the importance of the early planning period for a rail transit system.

- Close coordination of land use and transit planning is desirable if a rail system is intended to produce significant land use impacts.

- Community support for higher density development is necessary if high-density nodes of residential and commercial development in station areas are to be realized.

- Station area sites must be available for new development, and must be appropriately zoned.

- Supportive public policy can help shift demand into station areas.

- Favorable market conditions are necessary for new development. The BART experience has demonstrated that a rail transit system by itself cannot reverse declining trends or institute growth trends in areas which are blighted or depressed.

- Opportunities for public improvements which can enhance the urban development impacts of a rail transit system should be identified, funded, and scheduled to coincide with the construction of the system to minimize disruption. Such improvements can provide the necessary support for new development in the transit station areas.

- Community support for plans for the design and location of rail transit facilities is necessary if extensive negotiations, delays in construction, and changes to the system design are to be avoided during the construction process.

- The environmental impacts of a massive, extensive new rail transit system can be minimized, as have BART's, through careful design which takes into account the character of the communities in which facilities are to be placed. Landscaping is an important factor in making the transit facilities attractive.

Mitigation of adverse environmental impacts requires that planners make choices among alternatives; environmental, cost and service goals must be considered. For example, BART's environmental impacts have been minimized by the placement of a large portion of the system within existing transportation rights-of-way. Such locations are cost-effective and they minimize the dislocation of residences and businesses. However, they are not always the best locations for rail transit stations in terms of providing convenient access or inducing residential and commercial development. Some compromise solutions may be more effective.

- The purchase of wide rights-of-way in residential neighborhoods can minimize the impact of train sound, but this advantage must be balanced against the increase in cost and the displacement of homes and businesses.

- Noise-blocking devices on the trackways may mitigate the impacts in sensitive areas. Their addition increases the capital cost of rail transit systems, to some extent.

- A line, station, and parking lot might be moved a short distance from residential areas to diminish the adverse impacts, with some adverse effects on the accessibility of the system.

- Subway configuration eliminates all train sound, but subway construction is much more expensive than above-ground construction.

- Good feeder bus service to residential stations can help to reduce traffic on neighborhood streets. However, extensive bus service is rarely economically feasible in low-density suburban communities.

The lack of a lasting BART impact on property prices and rents suggests that a "value capture" policy -- a policy designed to tax increases in property values near a transit station which are directly attributable to the system -- is unlikely to yield substantial revenues, particularly in the early period of rail transit operations. Although the BART experience suggests that there may be little justification for a financing plan for rail transit which involves a value capture principle, this experience may not be universally applicable. A transit system designed explicity to attract high density developments for which there is support from public policies and market demand might induce sufficient increases in land and property prices to justify a value capture policy.

BART's capital costs and the experience of BART in developing a technologically advanced system demonstrate the dilemmas public officials and transit planners face in forecasting costs and devising a financing plan. BART was in the spotlight in the Bay Area, particularly because it was a locally-funded project. Its budgeting, expenditures, and operations have been closely scrutinized by local residents.

- Original cost estimates were based on existing rates of inflation and on the expectation that construction would proceed without major delays. In fact, inflation rates rose rapidly, particularly in the last few years of the construction period.

- Strikes, lawsuits, and negotiations with local communities delayed the construction activities. The cost of each delay was compounded by inflation.

- Additions to the scope of the system in response to community demands increased costs, but these increases were minor when compared with the effects of inflation.

- Increased construction costs led to funding shortages. In an effort to complete the construction of the system with the funds provided, BART eliminated some planned features which would have helped to improve the system's performance. For example, an auxiliary set of trackways in the Oakland junction and some sidings and cross-over trackways were removed from the plans. As a result, the effects of equipment problems have been exacerbated by the lack of facilities

for removing malfunctioning trains from the main-line trackways. This has caused frequent service delays throughout the system.

Many of these events could not have been foreseen. Moreover, extremely large contingency provisions in the original budget projections would undoubtedly have been viewed with suspicion by the voters who authorized funding for the system. On the other hand, cost overruns inevitably generate severe criticism and unfavorable attitudes toward a public agency.

This aspect of the BART experience demonstrates a need for flexible funding for rail transit systems to provide for unforseen contingencies during the construction process. However, local governments seldom have the financial resources or the support of local taxpayers for flexible funding. Moreover, it is difficult for a locally-funded operating agency to allocate sufficient time and money to test, de-bug, and retrofit a technologically advanced system such as BART. This suggests that the development of new rail technology is most appropriately accomplished by federally-funded research and development projects, and that federal funding should be made available for unexpected events, such as spiralling inflation, which are beyond a transit agency's control.

The effects of budget constraints and cut-backs in some features of the system continue to affect BART's service today. The service has been unreliable, and patronage levels are lower than anticipated. BART has devoted considerable resources to improving the system's performance, and system reliability has improved. Patronage can be expected to increase, and BART's impacts may become more widespread as service improvements are made.

BART, at its present service and patronage levels, has increased travel capacities and travel in the constrained corridors it serves. A modern, attractive rail system such as BART can attract motorists from their cars, and it can capture a significant proportion of the trips made in the corridors it serves. However, traffic congestion is unlikely to be permanently reduced in the corridors in which a rail transit system is most likely to be built-- corridors where travel demand is high and increasing. The highway space made available when motorists switch to a rail transit system will be quickly utilized for other trips in such a situation.

BART is serving a substantial proportion of the trips it was designed to serve best--long-distance trips between suburban areas and central cities. The system has influenced the location of some new construction in the communities it serves. An important benefit which is difficult to measure is BART's symbolic value-- the system demonstrates a major public commitment to preserving the vitality of the central Bay Area.

The Impact Program's findings demonstrate that a rail transit system's effects are greatest where other supportive factors are present. These include zoning, public improvements, strong market demand, developable land, and community support. Without these supportive factors a rail transit system is not likely to have an important influence on land use

and urban development patterns in a mature metropolitan area that is already highly developed.

Additionally, the Program's findings indicate that the area in which impacts can be expected to occur is the area within which the majority of trips on the system originate--the primary service area. Few region-wide BART impacts have been identified.

Finally, the major findings of the Program imply that goals for a new rail transit system must be based on choices between alternative sets of costs and benefits. Difficult planning and policy decisions must be made to allocate costs and benefits among the communities in a region, and between groups of citizens in the population. The Program's findings indicate the consequences of a number of alternatives, but communities planning transportation improvements must make the appropriate choices on the basis of their individual priorities and needs.

APPENDICES

APPENDIX A

A DESCRIPTION OF THE BART SYSTEM AND THE BAY AREA

THE BART SYSTEM

The BART system consists of 71 miles of double trackway and 34 stations. About twenty miles of the line are underground; thirteen in tunnels built by boring or by cut-and-cover construction; three in a hard-rock tunnel on the Concord line, and four in the Transbay Tube beneath San Francisco Bay. The remaining fifty-one miles of BART trackways are at grade, on earth embankments, or on elevated structures. About 14 miles of the above-ground lines are in shared rights-of-way along freeways. Another 34 are in shared or purchased railroad rights-of-way.

The following description of BART's automatic train operations, the BART vehicles, and the performance of the system supplements the information about BART in Chapter 1.

BART AUTOMATIC TRAIN OPERATIONS

When BART was designed in the 1950's and 1960's, the technology for electric railways was well established in two applications: (1) urban subways, where trains ran slowly; and (2) commuter railroads, where speeds were high but trains did not operate at close intervals. BART trains, by contrast, were planned to run as often as every ninety seconds with an average system speed, including station stops, of forty-five miles per hour. Further, the planners' objective of providing convenient service made it desirable to avoid transfers from one BART line to another for the journey to San Francisco. To accomplish this, the system was planned with a complex merge point in downtown Oakland at the Oakland "wye" where the Concord and Fremont lines merge. When direct service is provided from the Richmond line to San Francisco, trains from three routes will merge at this point. The design of the merge is such that delays on one route tend to be propagated to other routes. It has been a source of frequent bottlenecks during revenue operations.

Existing railway technology was judged by BART's planners to be inadequate to meet the goals of high speeds and frequent, direct service. Therefore, the system was designed with a number of innovative features, and with an automatic train operations (ATO) system. The computerized ATO system supervises the dispatching, scheduling, and routing of trains. It regulates train speeds automatically and maintains safe distances between them. It also controls the opening and closing of train doors, the duration of station stops, and the display of information on platform signs. A train operator, who is on board each train, has supervisory duties. The operator can override automatic controls to operate train doors and to stop a train. The operator can run the train in a manual mode when necessary, at reduced speed.

The ATO system equipment consists of a central computer control complex with display boards, operators' consoles, and a back-up computer. The central computer schedules and dispatches trains and imposes schedule corrections. The automatic schedule correction feature was not used in a large-scale application prior to its development for the BART system.

In addition to the central computer, the ATO equipment includes thirty-six local train control centers throughout the system, with associated wayside equipment. The BART system's trackways are divided into stationary blocks, with an alternating current track circuit which is interrupted by the wheels and axles of the cars to detect the presence of a train in a block of trackway. The speed of the trains in blocks behind the detected train is controlled to maintain the proper distances between the trains. The signalling system utilizes conventional railway technology. The wayside equipment is designed to perform train spacing functions without the supervision of the central computer.

The ATO system includes vehicle control equipment on board all trains, and utilizes a circuit to stop trains at precise locations at station platforms. This is an innovative concept whch has performed reliably after some debugging during the early stages of BART's operations.

A transmission system relays information between the central control complex, the local control centers, and other remote locations. In addition, the central computer monitors electrification and support facilities including fire alarms, ventilators, and pumps.

At the present time the central computer's functions have been expanded to include the maintenance of required distances between the trains, a function for which the wayside equipment was originally designed. This modification was necessary because a failure to detect a vehicle on the trackway under certain unusual conditions, identified during an early pre-operational test of the system, resulted in a ruling by the California Public Utilities Commission (PUC) that the wayside equipment must be expanded to include back-up train detection equipment. The PUC ruled that BART trains must be spaced at least one station (five to six minutes) apart until the back-up equipment was installed, tested, and approved, and until modifications to the optimum speed levels in certain sections of the trackway were made. These modifications are now completed and PUC hearings on the issue of lifting the restrictions on train spacing are being held.

BART VEHICLES

Each BART car is powered by four 150-horsepower motors, mounted one to each axle. Propulsion power is 1,000 volts of direct current, collected from a wayside third rail. The vehicles are equipped with both a friction and a dynamic braking system which uses the propulsion motors as generators to return power to the third rail during braking. A major BART innovation is the use of solid-state chopper control of propulsion and electric braking. The chopper control provides smooth acceleration and deceleration, and it reacts almost instantly to automatic commands. The steel wheels of the vehicles run on continuously welded steel rails

with rubber insulation. This provides a smooth, relatively quiet ride. The car body is a monocoque design; that is, the frame and body are the same. This was an innovation for mass rail transit systems and resulted in light-weight vehicles. The seats in the vehicles are cantilevered from the side walls, creating an open effect and providing for easy cleaning. They also provide a potentially safe design, since sidewalls do not warp as easily as the train floor in an accident. The BART vehicles were the first to be equipped with cantilevered seats in vehicles with light-weight side walls.

The BART cars are 10'6" wide, wider than most transit vehicles. BART operates two types of cars: "A" cars, which have a control cab at one end to house the train attendant and train control equipment, and "B" cars, which do not have control equipment. "A" cars weigh 59,000 pounds and "B" cars weigh 57,000 pounds. Both types have seventy-two seats and are 10'6" high. "A" cars are seventy-five feet long, and "B" cars are seventy feet long.

To achieve the goal of providing attractive and comfortable service, the interiors of BART vehicles were furnished with carpeting; wide, upholstered seats; and large tinted windows. The cars are air-conditioned. For stability at high speeds they operate on a wide gauge track (5'6"). The interiors contain sound-absorbent material to lessen noise levels. A public address system is used for communication between the train attendant and passengers.

SYSTEM PERFORMANCE

To date. the BART system has not achieved the performance levels or the level of reliability anticipated. Problems with the ATO system have resulted in longer train intervals than planned. Maximum frequencies are six minutes where routes converge, with twelve-minute train frequencies on each route. The ninety-second interval has been abandoned as a goal for BART; trains will operate at minimum headways of four-and-one-half to five minutes until further modifications are made to the system. A major obstacle to the achievement of closer headways has been the inability of the trains to consistently decelerate at the speed originally specified, due to wheel-rail adhesion problems which generally occur during wet weather. Solutions to this problem are being sought. Another obstacle is imposed by the back-up train detection equipment, which will not permit trains to operate at intervals greater than two to two-and-one-half minutes. Finally, the central computer has been found to be inadequate to handle more than 50 trains at one time. Replacement of the computer facilities is being planned for the next five-to-ten years.

The dependability of BART's service has been adversely affected by unexpectedly high failure rates in many components of the system. Although the failure rates of most components have been considerably reduced since the beginning of revenue service, the effects of equipment malfunctions are magnified in the BART system by the design of the junction in Oakland, and by the lack of adequate provisions for removing malfunctioning trains from the mainline trackway. As a result, service on the entire system is often slowed while a train is removed to a yard at a

reduced speed, in a manual operating mode.

Considerable resources have been allocated to remedying BART's reliability problems, and the system's reliability has improved. Continuing improvements in equipment, the lifting of PUC restrictions on operations, and the provision of additional sidings and trackways are expected to enhance the system's reliability in the future. Meanwhile, however, there is a widespread perception of BART as an undependable system, with consequent impacts on some peoples' willingness to use the system.

THE BAY AREA

The nine-county Bay Area has a population of 4.8 million persons. Half of the region's population, 2.4 million people, live in the three BART District counties. Fifty three percent of the employed persons in the Bay Area work in the BART counties. The population density of the BART counties is over twice that of the nine counties as a whole.

TABLE 38

POPULATION AND EMPLOYMENT IN THE BAY AREA
(1975)

	3-COUNTY BART DISTRICT		9-COUNTY BAY AREA
	Total	Percent of Region	
Sq.miles of useable land	1,360	19%	7,000
Population	2.4 million	49%	4.8 million
Employment	1.1 million	53%	2.0 million
Persons Per Useable Acre	14.60		5.83

Source: Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC), "Projections of the Region's Future", Berkeley, Calif. Sept. 1974

San Francisco and Alameda Counties have been the historic core of population and employment in the Bay Area. Since the 1950's a second core has developed around the City of San Jose, about 35 miles south of San Francisco in Santa Clara County, which is not served by BART. New electronics and aerospace industries which have located there because of the availability of land have attracted other commercial and residential developments. Santa Clara County is now the most populous and fastest growing county in the region. (See Figure 27.) By contrast, the population of San Francisco has declined since 1950. San Francisco and Alameda Counties continue to have the highest absolute levels of employment, but the growth rate in employment has been highest in Santa Clara County. (See Figure 28.)

POPULATION TRENDS IN THE SAN FRANCISCO BAY AREA 1950–1975
by county

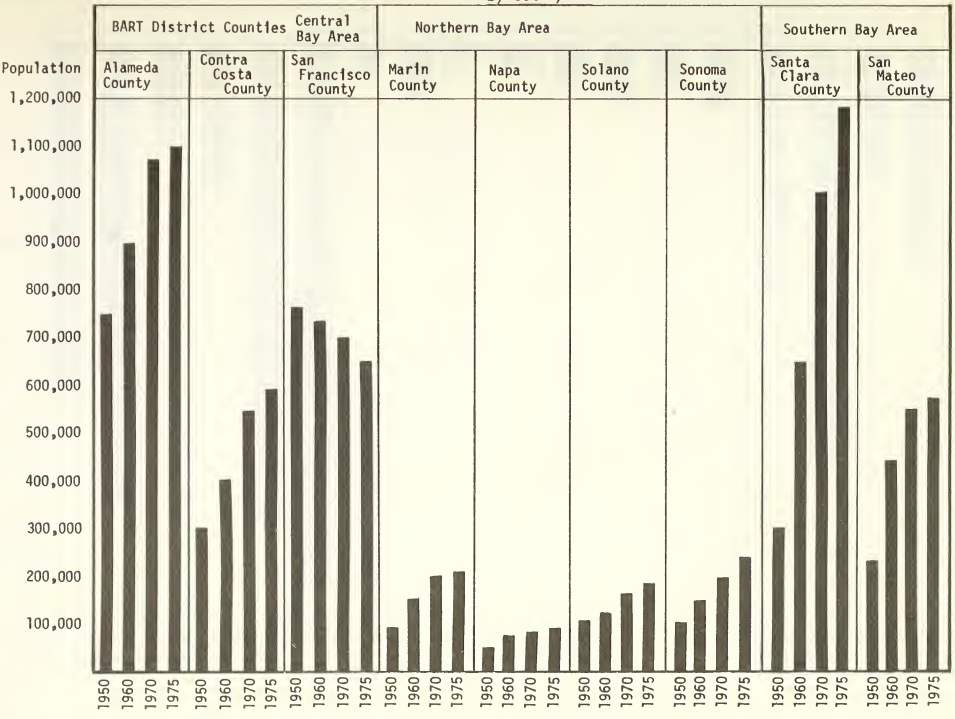


FIGURE 27

EMPLOYMENT TRENDS IN THE SAN FRANCISCO BAY AREA 1960–1970
by county *(all industries)*

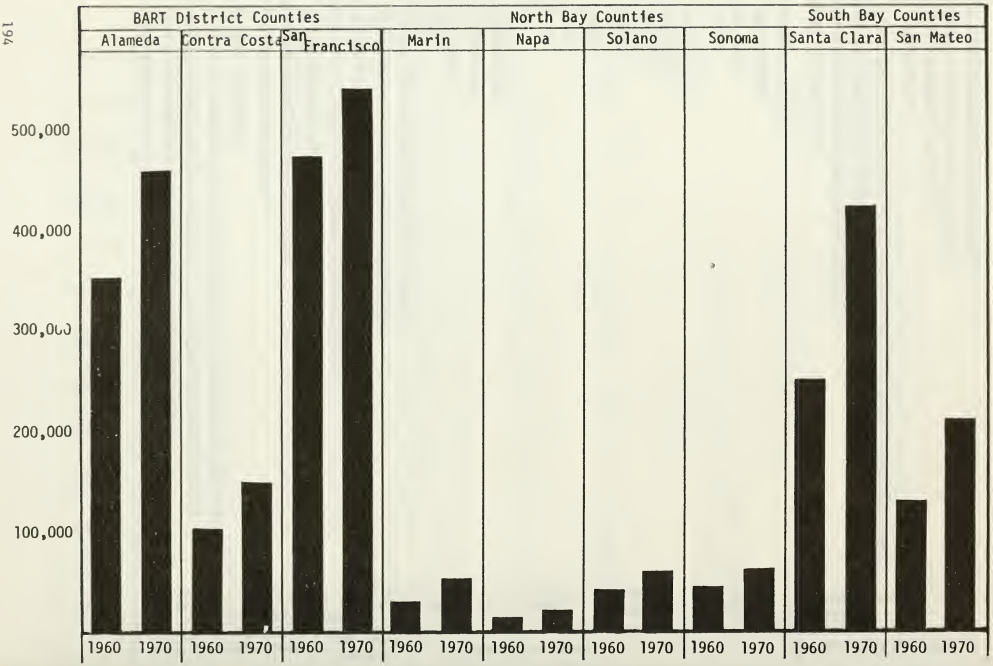


FIGURE 28

From 1962 through 1975 the number of new dwelling units built in each of the BART counties has remained a consistent proportion of the nine-county total, averaging 29% for Alameda County, 15% for Contra Costa County, and 6% for San Francisco County. By contrast, Santa Clara's share has ranged from 23-43% during the same period, averaging 31%.

The nature of the leading economic activities in several Bay Area counties in 1960 and 1970 is shown in Table 39. San Francisco lost employment in retail trade as well as in manufacturing during the decade, but the loss was more than compensated by an increase in service industry employment. The primary economic activity in Contra Costa County in 1960 was manufacturing, but by 1970 trade had become the leading industry. In Alameda County, state, federal, and local governmental activities became the County's leading industry by 1970. In Marin County, which is not served by BART, service industries displaced those engaged in trade. The character of the leading industries in the remaining Bay Area counties has not changed since 1960.

TABLE 39

LEADING INDUSTRIES IN THE SAN FRANCISCO BAY AREA COUNTIES
1960 AND 1970

	Leading Industry	
	1960	1970
Alameda	Trade	Government
Contra Costa	Manufacturing	Trade
San Francisco	Trade	Services
Marin	Trade	Services
Napa	----------Government----------	
Solano	----------Government----------	
Sonoma	----------Trade----------	
Santa Clara	----------Manufacturing----------	
San Mateo	----------Trade----------	

Source: Security Pacific Bank, Economic Research Department, "A Special Report on the Economy of the San Francisco Bay Area", San Francisco, 1975.

THE BART SERVICE AREA

BART enters or traverses 14 cities and a number of unincorporated areas in its three-county District. Approximately one million persons live within one mile of the BART trackways. Among the counties in which BART is located, San Francisco is the most densely populated, and is the major employment center, as shown in Table 40.

TABLE 40

POPULATION AND EMPLOYMENT IN THE BART DISTRICT COUNTIES
(1975)

	Population	Population Density	Employment
Alameda County	1.1 million	8.25 persons per acre	0.4 million
Contra Costa County	0.6 million	2.99 persons per acre	0.2 million
San Francisco County	0.7 million	33.23 persons per acre	0.5 million

Source: Security Pacific Bank, Economic Research Department, "A Special Report on the Economy of the San Francisco Bay Area", San Francisco, 1975.

About 85% of BART trips originate in the three counties in which BART is located. Another 10% originate in San Mateo County, which is on the peninsula south of San Francisco. (The BART Daly City station is located 0.2 miles over the San Francisco County line in San Mateo County.) Two percent come from Santa Clara County, and the remaining trips originate in other parts of the Bay Area.

San Francisco is the most fully developed of the three counties traversed by BART. Ninety-seven percent of its useable land is devoted to urban uses, compared to 71% in Alameda County and 47% in Contra Costa County.

San Francisco, like many other major cities throughout the country, has experienced a decline in population since the 1950's. However, new office development increased in San Francisco during the 1960's in contrast to the decentralizing trend in many other American cities during that period.

The City of San Francisco is served by the BART Daly City line, which runs underground from the downtown to Glen Park, and aboveground from there to Daly City. Four closely-spaced stations are located in the central business district. Outside the central business district the BART line passes through the Mission District, a densely populated, largely Hispanic, low-income area. The Glen Park, Balboa Park, and Daly City stations are beyond the Mission District in older, middle- income residential districts. Local public transportation throughout San Francisco is provided by the San Francisco Municipal Railway (MUNI) which operates buses, streetcars, and cable cars. MUNI buses provide feeder service to all San Francisco BART stations. A new light rail system, MUNI Metro, which is not yet in operation, shares the BART facilities in downtown San Francisco. The Metro system will operate underground, one

level above the BART tracks, along Market Street as far as the Civic Center. Beyond there, the two systems diverge and Metro extends another four miles to the southwest. The streetcars on Market Street will be replaced by the new system when it begins operations in 1980 or late 1979.

Regional access to San Francisco is provided by four bus systems and a railroad. The Alameda-Contra Costa County Transit District (AC) buses provide service over the Bay Bridge, paralleling BART from the East Bay to a bus terminal near the foot of Market Street in San Francisco. San Mateo County Transit District (SAMTRANS) buses provide service to downtown San Francisco from San Mateo County, as well as feeder service to the BART Daly City station. Greyhound operates buses to San Francisco from most Bay Area counties. The Southern Pacific Railroad provides limited commuter service from Santa Clara and San Mateo Counties to San Francisco. Bus and ferry service from Marin County is provided by the Golden Gate Bridge, Highway, and Transportation District.

The city of Oakland in the East Bay is served by BART's Richmond and Concord lines. (The Fremont line traverses the southwest section of the city but by-passes the downtown area.) The lines and stations in central Oakland are underground. Both population and employment in Oakland have declined in recent years. New office space has been added in downtown Oakland since 1960, but it has been accompanied by an increase in vacancies in older office buildings. AC buses provide feeder services to BART stations in Oakland, local service throughout the city, and express bus service to the downtown area from most areas in Alameda County and northern Contra Costa County.

BART's Richmond line serves the City of Berkeley, a residential, commercial and office center, and the location of a major University of California campus. It also serves a number of established residential communities in northern Alameda and Contra Costa Counties. AC buses provide local service within the area, feeder bus service to BART stations, and express bus service on routes paralleling BART's to downtown Oakland and San Francisco. BART contracts with AC for express bus service from the El Cerrito Del Norte Station to several areas in northern Contra Costa County which are not served by the rail lines.

The BART Concord line in Contra Costa County serves a predominantly suburban residential area which has grown rapidly during the past two decades. The hills in Contra Costa County confine regional travel to the Caldecott corridor which passes through a tunnel in the East Bay hills. BART lines and stations are in a freeway median in the corridor. BART contracts with AC transit for express bus service from the Concord and Walnut Creek stations to outlying areas in Contra Costa County. Some local public transportation is provided within the cities on the Concord line by AC buses under contract to the communities. Prior to BART, Greyhound lines provided commuter service in the Caldecott corridor. A majority of the Greyhound services were discontinued when their patronage shifted to BART.

The BART Fremont line serves southern Alameda County. It includes several stations in areas of light industry and depressed residential development within the city of Oakland. The cities of Union City and Fremont at the

southern end of the Fremont line have experienced vigorous growth and development in the past decade. However, much undeveloped land remains in the southern portion of the county. AC buses provide feeder service to Fremont line stations. Local service is provided Union City and Fremont; elsewhere AC buses provide service parallel to BART's to the central cities. BART contracts with AC for express bus service from the Bay Fair and Hayward stations to other nearby suburban areas.

APPENDIX B

CONCEPTUAL BASIS OF THE PROGRAM'S WORK

THE NO-BART ALTERNATIVE

The definition of the No-BART Alternative (NBA), the hypothetical regional transportation system used as a baseline to evaluate BART's impacts, is a critical element in the Program design. The purpose of the NBA is to isolate the net effects of BART from those changes which occurred as a result of factors other than BART. Therefore, the Program has defined a BART impact as the difference between what actually occurred in the Bay Area by 1976 with the BART system, and what is likely to have occurred up to that time if the hypothetical NBA had been in place.

The NBA definition is based on an analysis of the political and financial environment in the Bay Area at the time of the decision to build BART, and in the following years. This analysis suggested that no major new freeways and bridges would be built in the area as an alternative to BART.(Ref. 2) Existing transportation facilities were upgraded and expanded to some degree in the years between 1962, when the decision was made to build BART, and 1972. The NBA represents the transportation system which was in place in the Bay Area in 1973 with only a few, minor changes.

The level of service and the capacity provided by the NBA is not equal to that provided by the transportation system with BART in 1976. Neither is the level of mobility the same as that in the central Bay Area in 1976 with BART. The only capital cost associated with the NBA is the addition of 15 buses for peak-hour service in San Francisco. If the Program's evaluations had been based on the difference between BART's impacts and those of a new system of freeways and bridges, or of an express bus system, they would be markedly different in a number of respects.

Given the limitations in the analytical and theoretical state-of-the-art to forecast the future, the NBA is defined only as a transportation system alternative. It thus assumes no changes in the population, employment, and land use distributions from the actual case in 1976. There are inherent limitations to the amount of detail possible in the NBA description, given this definition. For example, while travel demand and accessibility can be estimated with some detail, the local NBA zoning policies have to be more judgmental and generalized. The effects of the NBA therefore are estimated indirectly in some cases, compared to estimates based on direct observations in the with-BART world.

The NBA includes all freeways and principal local streets which existed in 1976, but no additional highway facilities. There are relatively minor changes in the operations of the major transit services in the central Bay Area from the actual 1971 pre-BART base to the hypothetical 1976 NBA. 1973 was found to be a peak year for provision of transit service by Greyhound (commuter buses from central Contra Costa County to downtown Oakland and San Francisco) and AC Transit (transbay commuter buses). Those levels of service by those two carriers are retained in

the NBA. In the NBA small improvements in frequencies in the San Francisco MUNI's routes in the Mission corridor were made, but no new routes were introduced.

One major difference between the NBA and with-BART transportation system is the provision of transbay transit service by BART throughout the midday off-peak period, while the NBA contains little such service from some points and none from others.

Differences in annual transit patronage between the NBA and actual levels in fiscal year 1975-76 are shown in Table 41. As the table illustrates, actual transit patronage in the BART service area in 1975-76 was almost thirty-seven million trips per year greater than that assumed in the NBA scenario. The major difference is the thirty-three million trips made on BART.

Table 42 shows the difference in annual costs, revenues and deficits for the three major transit operators in the BART service area between the with-BART system and the NBA.

TABLE 41

ANNUAL TRANSIT PATRONAGE:
BART AND NO-BART ALTERNATIVE SCENARIOS
(in thousands)

	No-BART Alternative	1975/6 Actual	Difference
BART	-	32,900	+32,900
AC	55,500	56,022	+ 522
MUNI	116,000	122,000	+ 6,000
Greyhound	3,000	500	- 2,500
Total	174,500	211,422	+36,922

Source: Transit Operator Reports to the Metropolitan Transportation Commission and Impact Program Memoranda.

TABLE 42

ANNUAL REVENUES, COSTS, AND DEFICITS:
BART AND NO-BART ALTERNATIVE SCENARIOS
($000s)

	Net Fares		Operating Costs	
	NBA	1975/6 Actual*	NBA	1975/6 Actual*
BART	0	21,714	0	55,126
AC	16,700	15,394	41,900	44,678
MUNI	24,100	21,976	79,900	69,481
Total	40,800	59,084	121,800	169,285

	Deficit		
	NBA	1975/6 actual*	Difference
BART	0	33,412	- 33,412
AC	25,200	29,284	- 4,084
MUNI	55,800	47,505	+ 8,295
Total	81,000	110,201	- 29,201

*These numbers represent actual reported values. Corresponding numbers in Ref. 64, 65, and 66 are slightly different because they were obtained earlier as preliminary estimates.

Source: Transit Operator Reports to the Metropolitan Transportation Commission, and Impact Program Memoranda.

The major differences between the actual transit deficit in 1975/76 and that of the NBA are the $33,412,000 BART operating deficit, and the $8 million decrease in the MUNI deficit. The lower MUNI deficit is largely a result of cutbacks in MUNI service resulting from shifts of MUNI patrons to BART.

THE IMPACT PROCESS

The study of BART's impacts was organized in terms of the impact process, a conceptual chain of events which traces impacts to their causes in the attributes of BART and its environment, and ultimately to the decisions made in the process of planning and building the system. This concept was chosen to facilitate the transfer and use of the findings to other urban areas. It also provides insight into the nature of choices to be made in the planning process in terms of trade-offs between such factors

as patronage levels and environmental and land use impacts.

Figure 29 illustrates the impact process. The attributes of BART and the processes associated with its planning, construction and operations are grouped into major classes which are shown as column headings. They are: (1) the construction process; (2) facilities and operations; (3) transportation service; (4) fund flows associated with financing and expenditures for BART; and (5) the organization, planning and publicity for BART. The major facets of Bay Area life which are likely to be affected by the impacts are shown as categories in the row headings. The type of impact resulting from each attribute is displayed in the corresponding rows.

Examples of the major impacts which result directly from the system's attributes and those representing secondary, or indirect impacts are described below:

(1) THE BART CONSTRUCTION PROCESS: This attribute of the system represents the process of acquiring land and building a system. It is viewed as a purely physical process. The process results in a displacement of homes and businesses to provide space for the system's facilities. It also causes environmental effects such as noise, dirt and traffic disruption. Indirectly these environmental effects may affect retail sales and services of nearby businesses.

(2) ORGANIZATION, PLANNING AND PUBLICITY: The rapid transit agency was a new element in the political system whose powers, funds, personnel and purposes could affect other agencies and local governments. The planning and publicity associated with BART during its organization and the expectations elicited by these activities produced some impacts before BART began operations. For instance, some speculative real estate activities occurred, some local governments and governmental agencies changed their staffing patterns, at least temporarily, and some planning processes and planning decisions were influenced by the anticipation of BART's services and impacts.

(3) THE TRANSPORTATION SERVICE: The service provided by a rail transit system is the attribute which produces many of the major impacts. Many specific physical and operational features define the level and type of service provided. The transportation service directly affects travel behavior. Indirect effects for which evidence will be sought include changes in regional energy use, in air quality, in land use and urban development, and in economic growth. The transportation service may also have indirect effects on family routines and on the life styles of particular groups.

(4) FACILITIES AND OPERATIONS: This attribute refers to the rapid transit structures, such as stations and trackways, and to the operation of trains on the trackways. In other words, the presence of rapid transit structures and the operation of trains produce impacts on the physical environment even in the absence of passengers on the trains. The direct impacts affect the environment and persons living and working near the facilities. Indirectly, decisions about household and business

locations may be affected, and property values may be changed.

(5) EXPENDITURES FOR BART: The decision to build BART involved the expenditure of large sums of money which were drawn from a variety of sources. The expenditure of funds to build and operate BART and the tax burden and user charges imposed to pay for it affect the economic situation of the region and its inhabitants.

Direct and indirect impacts of BART can have a compounding effect on the impacts and even on attributes of the system itself. For example, changes in land use policies of local jurisdictions are likely to affect development patterns, and development around stations will affect ridership levels. In turn, levels of ridersip may affect the transportation service offered by BART, the level of revenues and operating deficits, and the nature of regional fund flows to support the system.

FIGURE 29

EXAMPLES OF THE IMPACT PROCESS

ATTRIBUTES OF BART

Impact Categories	Construction Process	Transportation Service	Facilities and Operations	Expenditures and Financing	Organization, Planning, Publicity
Travel Behavior	Changes in travel patterns	Levels and patterns of highway use; energy use; safety		Fares; operating revenue	
Environment	Noise; vibration; air quality; safety	Air quality; congestion on neighborhood streets; privacy	Noise; vibration; appearance		
Economics and Finance	Retail sales; construction wage rates	Employment accessibility; business; regional growth	Employment	Economic activities; employment; taxes; income;	
Land Use and Urban Development	Displacement of homes and businesses; speculation	Property prices and rents; housing, office, job, and store locations	Housing locations; property prices and rents	Property prices	Speculation; public policies; land use
Public Policy	Transportation planning for local jurisdictions	Transit service planning	Land use policy and planning	Taxation policies	Local governmental activities; political organizations

ANNOTATED BIBLIOGRAPHY*

CHAPTER 1 - INTRODUCTION AND BACKGROUND

1. Gruen Associates, "A Description of BART: Its Facilities, Service and Surroundings." WP 44-4-77. MTC, 1977.

   Describes the BART system, its operations, costs, and ridership. Characteristics of the population, employment, and land uses in the nine-county Bay Area are also described.

   NTIS No. PB 287 338/AS 122 pp $6.50

2. McDonald & Smart, Inc. " A Generalized No-BART Alternative Transportation System." FR 1-14-75. MTC, 1975.

   Formulates the generalized No-BART alternative transportation system for use in the BART Impact Program. Alternative transportation developments which are likely to have been implemented in the absence of the Bay Area Rapid Transit System have been identified, based upon policy assumptions defining the probable decision environment in the San Francisco Bay Area. The policy assumptions are documented by interviews with decision makers and documentary research in decision variables such as planning, growth trends, transportation demands, interest group influences, and financing sources.

   NTIS No. PB 242 438/AS 195 pp $7.25

3. McDonald & Smart, Inc. "A History of the Key Decisions in the Development of Bay Area Rapid Transit (BART)." FR 3-14-75. MTC, 1975.

   Describes the key decisions in the planning and implementation of Bay Area Rapid Transit (BART) during the period 1947 through 1974. The decisions are analyzed in terms of the influences brought to bear upon the decision-making process.

   NTIS No. PB 245 617/AS 209 pp $7.00

*Documents with NTIS numbers are available to the public through the National Technical Information Service, Springfield, VA 22151, at the prices noted.

4. John Blayney Associates/David M. Dornbusch & Co., Inc. "Study of BART's Construction Impacts." WP 48-5-77. MTC, 1978.

   An examination of the effects of BART's construction activities on retail sales and services and on real property. Key informant interviews were supplemented by longitudinal data on taxable retail sales and on permits for construction in areas near BART.

   NTIS No. PB 288 653/AS 50 pp $4.50

5. John Blayney Associates/David M. Dornbusch & Co., Inc. "BART's Consumption of Land and Property." WP 55-5-78. MTC, 1978.

   A documentation of BART's consumption of land and property occupied by businesses or residents. The relocation process and the development on surplus land acquired by BART is described.

   NTIS No. PB 287 797/AS 56 pp $5.25

6. Booz, Allen & Hamilton, Inc. "Impact of BART on Governmental Structure, Organization and Operations." WP 29-8-77. MTC, 1977.

   An assessment of BART's impact on local, regional and state governmental structure, organization and operations; on the formation and cohesion of private and community groups; and on municipal incorporation attempts in the BART District counties.

   NTIS No. PB 2829 44/AS 59 pp $5.25

7. Booz, Allen & Hamilton, Inc. "The Impact of BART on State Highway Plans and Policies." WP 30-8-77. MTC, 1978.

   Analyzes the impact of BART on state highway plans and policies. BART impacts evaluated include changes in highway facility development to access or parallel BART, changes in state highway policies with respect to BART, and the outcome of agreements between the state and BART on joint use of highway facilities.

   NTIS No. PB 2829 25/AS 56 pp $5.25

8. Booz, Allen & Hamilton, Inc. "The Impact of BART on Local Government Expenditures, Revenues and Financial Policies." WP 31-8-78. MTC, 1977.

   An assessment of BART's impact on local government expenditures, revenues and financial policies in the Bay Area. The paper includes a comparison of financial trends in Bay Area cities with California cities in general and findings and conclusions on BART's impact on local tax rate decisions, local expenditures and revenues and the financing of local capital improvement projects. A preliminary discussion of local financial policy implications is included.

   NTIS No. PB 291 956/AS 69 pp $6.00

9. Booz, Allen & Hamilton, Inc. "The Impact of BART on Land Use and Development Policy." WP 41-8-77. MTC, 1977.

Assesses the relationship between the construction and operation of BART and changes in local land use policy and resulting changes in actual land use and development. This study presents findings in four areas: (1) local government involvement in BART station location and design decisions related to land use policy; (2) BART impacts on local government planning studies, rezonings and use of special development incentives or controls; (3) BART impacts on local government policy regarding BART-related joint development, particularly public improvements, redevelopment and marketing; (4) the impact of BART-related land use policy upon actual changes in land use and development.

NTIS No. PB 291 957/AS 92 pp $6.00

10. Booz, Allen & Hamilton, Inc. "The Impact of BART on Local Transit Services and Financial Policy." WP 42-8-17. MTC, 1977.

Assesses the public policy impacts of BART on existing and planned local transit service and its financing in the three BARTD counties in the San Francisco Bay Area. Three specific policy areas were considered: (1) the impact of BART on changes in service, routes, fare, transfer and personnel policies of existing local transit operators; (2) the impact of BART on the creation of new local transit systems to provide feeder service to BART as well as local transit service; (3) the impact of BART on changes in state, regional, or local policies for financing local transit service.

NTIS No. PB 292 402/AS 119 pp $3.00

11. Booz, Allen & Hamilton, Inc. "The Impact of BART on Public Policy." FR 13-8-78. MTC, 1977.

Summarizes findings and conclusions of the Public Policy Project and presents policy implications for other metropolitan areas. Impacts of public policy actions are summarized in four areas -- organization, finance, land use, and transportation.

(NTIS number not yet available.)

12. Jefferson Associates, Inc. "Impacts of BART on Bay Area Political Institutions." TM 32-6-77. MTC, 1977.

Describes the effects of BART and BART-related phenomena upon the process of political mobilization, political organization, and local political activity within two case study communities near BART stations. Policy implications of the research findings are also included.

NTIS No. PB 273 389/AS 56 pp $5.25

13. Parsons, Brinckerhoff, Hall & MacDonald. "Regional Rapid Transit". San Francisco: H.S. Crocker Co., Inc., 1956.

Report to the Bay Area Rapid Transit Commission on the development of a coordinated rapid transit plan. The plan is formulated from basic studies which include a generalized plan of regional development; analyses of time, mode and purpose of interurban trips as revealed by an origin-destination survey; and analyses of the general economic and physical factors of private and mass transportation. Preliminary construction plans and cost analyses are included for that portion of the transit plan recommended for first stage construction.

14. Parsons Brinckerhoff-Tudor-Bechtel. "The Composite Report: Bay Area Rapid Transit, May 1962." San Francisco: 1962.

Report submitted to the San Francisco Bay Area Rapid Transit District describing the engineering, financial and economic phases of a rapid transit plan for Alameda, Contra Costa, and San Francisco Counties. They present the findings, conclusions, and recommendations of the engineering and financial consultants retained by the BART District, including an analysis of the need for and benefits of the system.

See also references 3, 19, 21, and 26.

15. Bolt, Beranek & Newman, Inc. "Acoustic Impacts of BART: Interim Service Findings." TM 16-4-76. MTC, 1976.

    Study of BART sound and vibration levels. The findings focus on: delineation of impacted regions, major factors affecting BART-generated sound, prototype vs. operational sound levels, BART vs. other transportation sound sources and BART-generated vibration levels. BART-generated sound levels were derived from direct wayside measurements and indirectly from on-board recording of sound levels throughout the BART system. Ambient community sound levels were based on predictive techniques verified by field measurements.

    NTIS No. PB 254 966/AS $5.00

16. Carp, Frances M. "Theory Background for Study of BART's Impacts on Perception and Response." WP 23-4-76. MTC, 1976.

    A review of behavioral science literature relevant to human perception and response. It outlines a possible strategy for the use of behavioral science theory: a conceptual model of the impact process is suggested which includes the element of human response and its determinants. An extensive bibliography is also included.

    NTIS No. PB 258 368/AS $4.50

17. Curtis Associates & Gruen Associates, Inc. "Community Monitoring of the Environmental Impacts of BART." WP 22-4-76. MTC, 1976.

    A study which employed a variety of non-random, qualitative techniques to gain information on the general nature of community concerns for and responses to BART. This information served to verify that the major physical impacts perceived by the persons affected were being studied. Additionally, it provided indications of the kinds of questions, language and direction the Environment Project's survey of response to impact should employ for the most meaningful results.

    NTIS No. PB 258 369/AS $4.00

18. DeLeuw, Cather & Co. "Impacts of BART on the Natural Environment: Interim Service Findings." TM 17-4-76. MTC, 1976.

    Study done on the impacts of BART on the natural environment. The general subject area is divided into three categories: (1) biota (wildlife & vegetation); (2) soils and geology; and (3) drainage & water systems. Since almost the entire area traversed by BART is urbanized and fully developed, this natural environment was not a major topic of study. However, a

comprehensive review of BART's possible impacts was performed because impacts on the natural environment are often not apparent even when they are quite significant from an ecological point of view.

NTIS No. PB 251 571/AS 79 pp $5.00

19. DeLeuw, Cather & Co. "Analysis of Pre-BART Urban Residential Environment Survey." WP 24-4-76. MTC, 1976.

An analysis of a 1972 home interview survey of 2,541 persons living near BART, after most of the system's construction but before its operation. Most of the survey dealt with anticipated rather than actual impacts, although perceived impacts of the system's construction were included. The analysis emphasized tests of the significance of relationships between perceived (or anticipated) BART environmental impacts and hypothesized determinants of those perceptions including specific characteristics of BART, its physical setting, and the respondents themselves. Results of the analysis included the finding that most residents had very favorable attitudes and expectations regarding BART's effects on them. Variations in these responses tended to be related mainly to the respondent's distance from BART and his or her plans to make use of the system.

NTIS No. PB 258 379/AS 50 pp $4.50

20. DeLeuw, Cather & Co. "Environmental Impacts of BART: The User's Experience." TM 23-4-77. MTC, 1977.

Study of the BART travel experience -- the immediate effects of BART as an "environment" for its users. The BART trip is described as a process, following the user from the desire to take a trip to the completion of that trip and exit from the BART system. BART characteristics to be encountered at each stage of the trip are described and evaluated. Conclusions and implications for design of future transit systems are drawn.

NTIS No. PB 280 200/AS 140 pp $8.00

21. DeLeuw, Cather & Co. "Responses of Nearby Residents to BART's Environmental Impacts." TM 25-4-77. MTC, 1977.

Study of BART's environmental impacts as viewed by the nearby residents who are exposed to those effects. Most data for the analysis are from a home interview survey of some 700 persons living in ten case study sites, most within four blocks of the tracks or station parking lots. Perceptions, evaluations and behavioral responses reported by residents are compared with the study's earlier impact assessments made by staff. Influence of various BART attributes on the responses is derived. Conclusions and implications for design of future transit systems are drawn.

NTIS No. PB 280 202/AS 166 pp $9.00

22. Gruen Associates, Inc. "Impacts of BART on Visual Quality: Interim Service Findings." TM 18-4-76. MTC, 1976.

The Phase I visual quality assessment evaluated the effects of BART on the adjacent visual environment in terms of appearance, illumination, and shadows. Both the regional and local visual impacts of BART on the Bay Area were assessed. The regional scale assessment identified and evaluated the repetitive visual elements of BART which could be perceived at the regional level and some of the urban form implications of the BART system on the Bay Area. The local scale assessment examined the impacts of transit facility improvements which have taken place in the visual environment immediately adjacent to the BART right-of-way. The purpose of the nighttime illumination study was to determine what effect direct visible light sources, such as train lights, station lighting and parking lot illumination, have on nighttime visual environments. The shadow study evaluated the effects of shadowing on areas adjacent to elevated and at-grade guideways and stations.

NTIS No. PB 257 509/AS $4.50

23. Gruen Associates, Inc. "Impacts of BART on the Social Environment: Interim Service Findings." TM 19-4-76. MTC, 1976.

The Environment Project's definition of the term "social environment" is a narrow one, based on the study's concern with the effects of BART as a physical entity. In this context, the impacts of interest are primarily those which influence the interactions of people in the vicinity of BART. The effects of BART's facilities on privacy are also included. Four impact categories were used to organize this assessment: barriers, safety (against bodily harm), security (against threats to persons or property), visual exposure. The effort included the gathering of complementary types of data, widespread interviews with BART and community officials, consultations with knowledgeable professionals, and direct observation in specific locations.

NTIS No. 257 510/AS $6.00

24. Gruen Associates, Inc. "Indirect Environmental Impacts." TM 24-4-77. MTC, 1977.

Documents land development and land use policy changes which have occurred in BART station areas between 1965 and 1975 and assesses the environmental impacts associated with development and policy changes near twelve BART stations. In addition, it describes and evaluates changes in station area development quality in terms of public improvements made to some of these areas.

NTIS No. PB 280 201/AS $7.25

25. Gruen Associates, Inc. and DeLeuw, Cather & Co. "Environmental Impacts of BART: Interim Service Findings." FR 2-4-75. MTC, 1976.

A summary of the results and accomplishments of the Environment Project's initial study phase, concentrating on BART's immediate effects on the physical dimensions of the urban ecosystem.

NTIS No. PB 257 498/AS $6.00

26. Gruen Associates, Inc. and DeLeuw, Cather & Co. "Environmental Impacts of BART: Final Report." FR 7-4-77. MTC, 1977.

Summary of the results and accomplishments of the Environment Project of the BART Impact Program. The study consisted of a detailed assessment of BART's current environmental impacts, including direct (i.e., wayside) impacts as well as indirect impacts (resulting from development in BART station areas) and effects on the system's patrons. Assessment was made using both technical impact evaluations (e.g., noise measurements) and surveys of the responses of those affected. In addition, indications of BART's construction impacts and future impacts associated with the system's full-service level of operations are described and evaluated.

(NTIS number not yet available.)

27. John Blayney Associates/David M. Dornbusch & Co., Inc. "Accessibility Mapping." WP 36-5-77. MTC, 1977.

Addresses BART's effects on accessibility at a regional scale and within station areas. Several accessibility measures are presented, and differences between BART and the No-BART Alternative (NBA) delineated. Auto access times to selected BART stations are mapped and compared with the frequency distribution of travel times to BART reported in the Passenger Profile Survey. The maps and accessibility measures were used in analyzing BART's effects on office construction and the housing industry, workplace and residence location decisions, retail sales trends, property values and rents, and other facets of urban development.

(NTIS number not yet available) 34 pp

28. (Same as Reference 33, which see.)

29. California State Department of Transportation (CALTRANS) "BART Impact Vehicle and Person-Movement Study:Collection Methodology for Pre-BART Data". TM 2-1-74. MTC, 1974.

Documents the methodology used to collect vehicle and person-movement data for the BART Impact Program in the period prior to BART revenue operations. The report describes the organization and procedures used in collecting the data, including types, locations, dates and duration of counts. It also describes jurisdictional responsibility, coordination of public and private agencies involved, and cost estimates.

NTIS No. PB 235 038/AS 31 pp $8.75

30. Peat, Marwick, Mitchell & Co. "Immediate Travel Impacts of Transbay BART". TM 15-3-75. MTC,1975

Analyzes travel patterns in the transbay corridor in the period before and immediately after the start of transbay BART service in September, 1974. Aggregate transbay travel by automobile and transit is analyzed in terms of historical trends and seasonal and short-term variations, and impacts

on traffic congestion are analyzed using highway travel time survey data. The results of on-route surveys of transbay travelers using automobile, bus, and BART provide evidence of the origin-destination pattern of transbay trips, their purposes, the profiles of travelers, and information on factors of mode choice.

NTIS No. PB 245 983/AS 110 pp $6.25

31. Peat, Marwick, Mitchell & Co. "Exploratory Network Analysis of BART'S Impacts Upon Accessibility". WP 15-3-75. MTC, 1977.

The study made a preliminary assessment of BART's impacts on areawide accessibility and evaluated the use of network-based accessibility measures as an impact analysis technique.

NTIS No. PB 244 088/AS 133 pp $4.75

32. Peat,Marwick, Mitchell & Co. "BART-NBA Accessibility". WP 59-3-78. MTC. 1978.

Network-based accessibility measures are described and analyzed.

(NTIS number not yet available)

33. Wolfgang S. Homburger, Frederick C. Dock, Institute of Transportation Studies, University of California, Berkeley. "Trends in Traffic Patterns at the Bay Bridge and Caldecott Tunnel". WP 32-3-77. MTC,1977

Utilizing multiple regression techniques, this paper presents an analysis of the effects of the opening of the Bay Area Rapid Transit (BART) System's transbay crossing on the traffic at two major highway facilities, the San Francisco-Oakland Bay Bridge and the Caldecott Tunnel. Looking at data collected semi-annually since 1965, it was found that there was a sudden shift in trend lines in 1974 after the BART Transbay Tube was opened. Vehicle volumes dropped, transit patronage jumped, but total person trips in the short run followed roughly the trends of the previous eight years. Transbay vehicle and transit traffic has increased at a more rapid rate since 1974, with mid-day off-peak transit patronage showing a large increase. While an important temporary phenomenon, the 1973-74 increase in gasoline prices was not found to contribute much to this sudden change in the long term trends. BART also caused the removal of a substantial number of buses from the two facilities, effectively increasing their vehicle-handling capacity. This has resulted in higher traffic flow rates during the height of the peak periods.

NTIS No. PB 270 370/AS 53 pp $4.50

34. Peat, Marwick, Mitchell & Co. "Transportation and Travel Impacts of BART: Interim Service Findings." FR 6-3-75. MTC, 1976.

Summarizes BART's initial impacts on the regional transportation system's performance and on travel patterns. The report deals with the effects of interim BART service over the period September, 1972 through June, 1975. Impacts are assessed in terms of BART's design and operating characteristics; its service levels; changes in accessibility; the level and nature of BART's ridership; impacts on travel by bus and automobile; impacts on the service provided by the rest of the transit system; and impacts on traffic congestion BART's capital costs, interim operating costs and revenues, and interim energy consumption are also analyzed.

NTIS No. PB 261 017/AS 192 pp $7.75

35. Peat, Marwick, Mitchell & Co. "BART's Impacts on Highway Traffic and Transit Ridership." TM 20-3-76. MTC, 1977.

Documents the changes in aggregate highway traffic volumes, traffic congestion, bus ridership, and bus services which took place in the four years after BART service began, and assesses the extent to which these changes may be attributed to BART.

NTIS No. PB 267 675/AS 145 pp $6.75

36. Peat, Marwick, Mitchell & Co. "Explanatory Modeling of Transbay Travel Choice." WP 34-3-77. MTC, 1977.

Analyzes the reasons underlying BART-bus and BART-automobile travel choices in the key transbay travel corridor. Travel modes are described in terms of fourteen service attributes such as travel time, cost, dependability, and safety. Disaggregate models which relate mode choice probability to perceived satisfaction with the alternative modes are estimated using data for the fourteen attributes collected. Several different models are estimated and compared for BART-bus and BART-auto choices, for work and non-work trip purposes, for geographic stratifications of the data, and with linear and logit functional forms.

NTIS No. PB 273 395 AS 110 pp $6.50

37. Peat, Marwick, Mitchell & Co. "Travel in the BART Service Area." WP 35-3-77. MTC, 1977.

Analyzes the results of the May 1976 BART Passenger Profile Survey and the May 1975 Areawide Travel Survey. Both surveys are briefly described in the Methodology section of this report. The report provides information about the socioeconomic characteristics of BART, bus, and automobile travelers, the

purposes and characteristics of their trips, and the shares of areawide travel carried by the various modes. The report also includes 1970 U.S. Census data showing the socioeconomic characteristics of the population of the BART service area.

NTIS No. PB 273 393/AS 124 pp $6.00

38. Peat, Marwick, Mitchell & Co. "BART's First Five Years: Transportation and Travel Impacts." FR 11-3-78. MTC, 1978.

The final report of the Transportation Systems and Travel Behavior project describes the BART system, the service it provides, its impacts on accessibility, and the nature and determinants of ridership on the system. BART's share of Bay Area travel is documented. Impacts on highway volumes, traffic congestion, bus ridership, and service levels are assessed, and the costs of building and operating the system are shown.

(NTIS number not yet available) 202 pp

See also reference 41.

39. Jefferson Associates, Inc. "Impacts of BART on Bay Area Health Care Institutions." TM 22-6-77. MTC, 1977.

    Describes the effects of BART on local health care institutions, as determined by surveys of patient travel to medical care facilities and interviews with administrative personnel.

    NTIS No. PB 266 614/AS 40 pp $4.50

40. Jefferson Associates, Inc. "Impacts of BART on Bay Area Institutions of Higher Education and Their Students." TM 31-6-66. MTC, 1977.

    Describes the impacts of BART on institutions of higher education and on student life styles.

    NTIS No. PB 273 396/AS 90 pp $6.00

41. Jefferson Associates, Inc. "Social Impacts of BART on Bay Area Families and Life Styles." TM 21-6-77. MTC, 1977.

    Describes the impacts of BART on families and the life styles of BART users. The impacts are evaluated in nine dimensions of life style routines. Policy implications of the research findings are included.

    NTIS No. PB 286 509/AS 146 pp $7.25

42. Jefferson Associates, Inc. "Impacts of BART on Bay Area Institutions and Life Styles: Final Report." FR 10-6-77. MTC,1978.

    This report focuses on the effects of BART on the social institutions and life styles of Bay Area residents. It is the Final Report of the Institutions and Life Styles Project. The impacts on three primary institutional spheres are evaluated: local political institutions, including community responses to BART; institutions of higher education and their students, and health care institutions and their clients. Case studies designed to assess BART-related changes in organizational activities and in the social experience and expectations of the participants are described. The study of life style impacts was focused on the direct and indirect impacts of BART on the use and experience of a variety of transportation modes, as well as on household routines, commuters' experiences, and the family as an institution.

    (NTIS number not yet available)

43. TRW, Inc. "Impacts of BART on Air Quality: Interim Service Findings." WP 20-4-76. MTC, 1976.

This is a study of BART's impacts on local and regional air quality and microclimate. The assessment included effects on regional air pollutant emissions; carbon monoxide, reactive hydrocarbons, and oxides of nitrogen. Additionally, station area carbon monoxide emissions were assessed.

NTIS No. PB 257 511/AS $5.50

44. Gruen Associates and De Leuw Cather & Co. "Preliminary Findings-Regional Air Emissions." TM 14-4-75. MTC, 1975.

Describes changes in the emission of automobile-generated pollutants resulting from changes in vehicle miles of travel associated with BART.

NTIS No. TM 14-4-75 6 pp $3.25

45. Peat, Marwick, Mitchell & Co. "Analysis of BART's Energy Consumption for Interim System Operations." WP 14-2-75. MTC, 1975.

Investigates the historical energy consumption of the BART system, estimates BART's energy consumption for future service levels, and compares BART's energy consumption to that of other rail transit systems and alternate modes of travel.

NTIS No. PB 248 118/AS 18 pp $4.00

46. McDonald & Grefe, Inc. "Impacts of BART on the Competitive Advantage and Efficiency of Bay Area Business Operations." TM 26-7-77. MTC, 1977.

Evaluates the economic effects of BART's transportation service on the competitive advantage and efficiency of Bay Area businss operations. The scope of the analysis includes potential economic impacts resulting from improved service and accessibility for workers to jobs, the impacts on regional competitive advantage due to locational advantages or regional "image," and the possible economic efficiencies associated with BART service.

NTIS No. PB 237 485/AS 119 pp $6.50

See also references 15, 17, 19, 21-26.

47. John Blayney Associates/David M. Dornbusch & Co., Inc. "Land Use and Urban Development Project: Study of the Housing Industry." WP 37-5-77. MTC, 1977.

Addresses BART's effects on the housing industry in nine areas: Daly City-Pacifica, Mission District, Fruitvale, Walnut Creek, Hayward, Fremont-Union City, Pittsburg-Antioch, Richmond, and East Oakland. Changes in housing supply and demand during the period 1962-76 are analyzed.

NTIS No. PB 288 676/AS 70 pp $5.25

48. John Blayney Associates/David Dornbusch & Co. "Study of the Office Construction Industry." WP 33-5-77. MTC, 1977.

Evaluates BART's effects on the three-county BART service area office construction industry. The study addressed specific issues of BART's effects on regional office location, local office location, and the timing of BART-induced changes in office location patterns.

NTIS No. PB 288 678/AS 65 pp $5.25

49. John Blayney Associates/David Dornbusch & Co., Inc. "Study of Workers' Location Decisions." WP 38-5-77. MTC, 1977.

In this study of BART's effects on workers' job location decisions, the following questions were addressed:
- -Is BART accessibility important in job location decisions?
- -Is BART's influence related to prior transit use?
- -Does BART facilitate job searches?
- -Does BART have a greater effect on white collar workers' job location decisions than on those of blue collar workers?

NTIS No. PB 285 969/AS 84 pp $6.00

50. John Blayney Associates/David M. Dornbusch & Co., Inc. "Station Area Land Use." WP 39-5-77. MTC, 1977.

Summarizes time series data on BART stations compiled for the Land Use and Urban Development Project. Station area land use changes during the period 1965-77 are summarized.

NTIS No. PB 282 996/AS 29 pp $4.50

51. John Blayney Associates/David M. Dornbusch & Co.,Inc. "Study of Property Acquisition and Occupancy - BART's effect on Speculation." WP 45-5-78. MTC, 1978.

This study addresses specific issues of the timing and the extent as well as the character of BART-induced speculation. Information

from interviews with key informants was combined with quantitative analyses of data assumed to be indicative of speculation at eight study sites throughout the service area.

NTIS No. PB 290 147/AS 101 pp $6.00

52. John Blayney Associates/David M. Dornbusch & Co., Inc. "Study of Employers' Locational Decisions." WP 46-5-78. MTC, 1978.

Examines BART's influence on employers' location decisions in the three-county BART service area. Individuals who had participated in or who were familiar with their firm's location decisons were interviewed, and relevant interviews from other studies of the BART Impact Program were reviewed. Specific issues addressed in this paper include BART's direct and indirect effects on location decisions, BART's influence on centralization or decentralization of businesses and industries, and the extent to which firms have located near BART in order to gain visual exposure.

NTIS No. PB 288 677/AS 42 pp $4.50

53. John Blayney Associates/David M. Dornbusch & Co., Inc. "Households' Location Decisions." WP 47-5-78. MTC, 1978.

BART's effect on household location decisions in San Francisco's Mission District, suburban Walnut Creek and East Oakland are examined. Randomly selected households that had moved in the period 1975-76 were interviewed to determine factors affecting moving and location decisions.

NTIS No. PB 287 798/AS 92 pp $6.00

54. John Blayney Associates/David M. Dornbusch & Co., Inc. "Retail Sales and Service." WP 50-5-78. MTC, 1978.

This study focuses on BART's influence on the distribution and volume of sales in the Bay Area. A shopper survey was conducted, retailers were interviewed and sales tax data were analyzed.

(NTIS number not yet available)

55. John Blayney Associates/David M. Dornbusch & Co., Inc. "Development Patterns." WP 52-5-78. MTC, 1978.

BART's effects on Bay Area, corridor and station area land use are examined. The techniques utilized are regional regression analyses of BART's influence on population, housing and employment; statistical analyses of survey results; and key informant interviews.

NTIS No. PB 289 704/AS 120 pp $6.50

56. John Blayney Associates/David M. Dornbusch & Co., Inc. "Property Prices and Rents." WP 52-5-78. MTC, 1978.

Multiple regression analyses were carried out for eight study sites to determine BART's impacts on residential and commercial property prices and rents. Information from key informants was also used.

NTIS No. PB 292 401/AS 142 pp $7.25

57. John Blayney Associates/David M. Dornbusch & Co., Inc. "Long-Term Monitoring." WP 54-5-78. MTC, 1978.

Options for monitoring BART's impacts on land use and urban development are examined in terms of the importance for policy making, the probability of impact, and the feasibility.

NTIS No. PB 291 016/AS 55 pp $4.50

58. John Blayney Associates/David M. Dornbusch & Co., Inc. "Land Use and Urban Development Project Final Report." FR 14-5-78. MTC, 1978.

Assesses BART's land use and urban development impacts during its planning, construction and first five years of operations.

(NTIS number not yet available.)

59. Skaburskis, Andrejs. "The Impacts of BART on Property Values - A Case Study of the Rockridge Neighborhood." WP 19-5-76. MTC, 1976.

Describes BART's impact on the sale price of single-family houses in the Rockridge neighborhood in Oakland. Four specifications of an econometric model are discussed. Before-after, cross-sectional, and cross-sectional-longitudinal approaches are evaluated.

NTIS No. PB 258 367/AS 89 pp $5.00

60. John Blayney Associates/David M. Dornbusch & Co., Inc. "Program-Wide Case Studies." WP 53-5-78. MTC, 1978.

In-depth, policy-oriented case studies of BART's impacts on selected communities--downtown San Francisco and Oakland, representing urban core areas; the Mission District of San Francisco, The Rockridge neighborhood in Oakland, and Richmond, representing urban residential areas; and Walnut Creek and Fremont, representing suburban areas.

NTIS No. PB 291 388/AS 166 pp $8.00

See also references 3, 4, 5, 9, 11, 12, 15, and 26.

61. Bay Area Rapid Transit District. "Capital Program Report" for the period ending September 30, 1975.

Details capital funding and expenditures for the BART system.

62. Bartle Wells Associates. "The Impact of BART's Bond Issue on Regional Public Financing." TM 27-7-76. MTC, 1977.

This reports a study of the impact of BART's general obligation bond financing on the cost of public borrowing in the San Francisco Bay Area, and a study of the magnitude of the debt on the financing of other public projects. A statistical search of borrowing costs was made to determine if any changes which might be related to BART had occurred. Key informants in the bond industry were interviewed to determine their perceptions of BART's impacts in the area of public borrowing.

NTIS No. PB 273 387/AS 137 pp $7.25

63. McDonald & Grefe, Inc. "Theoretical Framework for the Evaluation of the Economic and Financial Impacts of BART." WP 25-7-77. MTC, 1977.

Outlines the theoretical framework for evaluating the economic and fiscal impacts of the construction and operation of the Bay Area Rapid Transit System. Impacts described in the Working Paper include direct construction expenditures, operating expenditures, impacts on the economy, fiscal burdens, and the impacts on the use of bonded debt in the Bay Area. The theoretical basis of the work to be done and the hypotheses to be tested are described.

NTIS No. PB 261 362/AS 68 pp $5.00

64. McDonald & Grefe, Inc. "Economic Impacts of BART Capital and Operating Expenditures." TM 29-7-77. MTC, 1978.

Documents the changes in regional output and employment in the nine-county San Francisco Bay Area which resulted from expenditures for BART's construction and operations. BART's impacts on employment opportunity and on construction wage rates are also evaluated.

NTIS NO. PB 283 061/AS 190 pp $9.00

65. McDonald & Grefe,Inc. "The Distribution of the Tax Burden of Financing BART's Construction and Operations." TM 30-7-77. MTC, 1977.

Identifies the sources of BART's capital financing and assigns the burden of each revenue source geographically as well as

to economic sectors. The equity of BART's financing methods is evaluated.

NTIS No. PB 282 990/AS 177 pp $9.00

66. McDonald & Grefe, Inc. "The Economic and Financial Impacts of BART." FR 8-7-77. MTC, 1978.

This Final Report of the Economics and Finance project documents the changes in regional sales, income, and employment in the nine-county San Francisco Bay Area which resulted from BART's capital and operating expenditures. BART's impact on employment opportunities for minorities and women is described. The tax incidence and tax burden of financing BART's capital and operating costs are identified. All elements of the project's work are described and summarized.

(NTIS number not yet available)

67. Peat, Marwick, Mitchell & Co. "Analysis of BART Capital Costs" WP 40-3-77 MTC, 1977.

This report documents the components of BART capital costs and analyzes the difference between the actual $1.6 billion expenditure for BART and the cost forecast of $994 million in the 1962 planning report.

(NTIS number not Yet Available)

See also reference 37.

68. Jefferson Associates, Inc. "BART Impacts on Travel by Ethnic Minorities." TM 33-3-77. MTC, 1978.

Assesses BART's impacts on travel by ethnic minorities by analyzing data from: (1) conventional large-scale travel surveys; and (2) special "field station" data collection efforts conducted by participant observers in ethnic minority communities. The latter were conducted in the predominantly Spanish heritage Mission District of San Francisco and the predominantly Black city of Richmond.

(NTIS number not yet available)

69. Metropolitan Transportation Commission. "The Provision and Use of the BART Facilities for Disabled Persons." WP 43-11-77. MTC, 1977.

Summarizes the results of several studies of the BART facilities for disabled persons. It includes a history of the provision of the facilities, a description of them and of BART plans to modify and expand them, and suggestions by disabled persons for their improvement. Interviews with disabled persons are reported to indicate the problems they have experienced in using BART and the impact the facilities have produced on their travel behavior.

NTIS No. PB 275 176/AS 54 pp $5.25

70. Urban Dynamics Associates. "Implications of BART's Environmental Impacts for the Transportation Disadvantaged." TM 34-10-78. MTC, 1978.

Focuses on the environmental impacts of BART's construction and operations on the transportation disadvantaged. The special population groups included in the analyses in this report are ethnic minorities (Black, Spanish heritage, Asians, and others), the elderly, and the handicapped. Six issues related to possible environmental impacts of the construction or operation of the BART system for the transportation disadvantaged are examined. Information developed in the major project areas of the BIP is applied in the investigation of each issue.

NTIS No. PB 283 022/AS 90 pp $6.00

71. Urban Dynamics Associates. "Implications of BART'S Mobility and Accessibility Impacts for the Transportation Disadvantaged." TM 35-10-78. MTC, 1978.

Integrates Program findings concerning BART'S mobility and accessibility impacts on ethnic minorities, the elderly and handicapped, and draws policy implications.

NTIS No. PB 286 760/AS 93 pp $3.00

72. Urban Dynamics Associates. "Implications of BART's Economic, Employment, and Financial Impacts for the Transportation Disadvantaged." TM 36-10-78. MTC, 1978.

Integrates Program findings concerning BART's economic, financial, and employment impacts on ethnic minorities, the elderly and handicapped, and draws policy implications.

(NTIS number not yet available)

73. Urban Dynamics Associates. "Implications for the Transportation Disadvantaged: Land Use and Urban Development Issues." TM 37-10-78. MTC, 1978.

Integrates Program findings concerning the range and incidence of BART's impacts on transportation-disadvantaged persons.

(NTIS number not yet available)

74. McGuire, Chester. "Who are the Transportation Disadvantaged?". WP 27-10-77. MTC, 1976.

The transportation disadvantaged are defined as groups whose opportunities for development have been hindered by deficiencies in the transportation system. Factors such as income, age, disability, place of residence, place of employment, automobile accessibility, race, and sex in terms of their relationship to transportation disadvantages are discussed.

NTIS No. PB 266 211/AS 57 pp

75. Urban Dynamics Associates. "Implications of BART's Impacts for the Transportation Disadvantaged." FR 12-10-78. MTC, 1978.

This is the final report of the Implications for the Transportation Disadvantaged Project. It integrates the study of BART's impacts on the transportation disadvantaged in each of four major impact areas--environment, mobility, economics and land use. The implications are presented in terms of the effects on policy considerations for other areas where similar systems may be considered.

(NTIS number not yet available)

See also references 12, 26, 36, 37, 39, 40, 41, 55, and 65.

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